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WITH THE BRITISH ASSOCIATION IN SOUTH AFRICA

By Professor ERNEST W. BROWN,
HAVERFORD COLLEGE

I.

THE visit of the British Association to South Africa during the past summer appears to have established the idea that its activities in future are not to be confined to the British Isles. Two successful oversea meetings had already taken place; the first at Montreal, in 1884, and the second at Toronto, in 1897, and there seemed to be no reason why the suggestion of a meeting in Cape Town, made as far back as 1898, by Sir David Gill, astronomer royal at the Cape, should not be followed up. But there were many difficulties in the way. It was obvious at the outset that few would be willing to make two long journeys by sea unless opportunities were afforded to visit the chief places of interest in other parts of South Africa. It was obvious too that few of those whose presence was chiefly desired would be in a position to afford the necessary expense unless very considerable assistance were forthcoming, and the general funds of the association were not intended, nor were they sufficient, for this purpose. Further, there are few towns where accommodation for several hundred visitors can be obtained, and this meant that special trains with dining and sleeping cars must be provided; the trunk lines in the colonies have a supply of rolling stock not much more than is sufficient for the few who travel long distances in South Africa.

While the matter was under discussion, war broke out. But those who were interested did not lose sight of the idea, and early last year it took more definite shape in generous offers of assistance from the governments and towns in South Africa. In the meantime, many changes had occurred. The new colonies must be included in the itinerary; opportunities must be afforded to see places and districts

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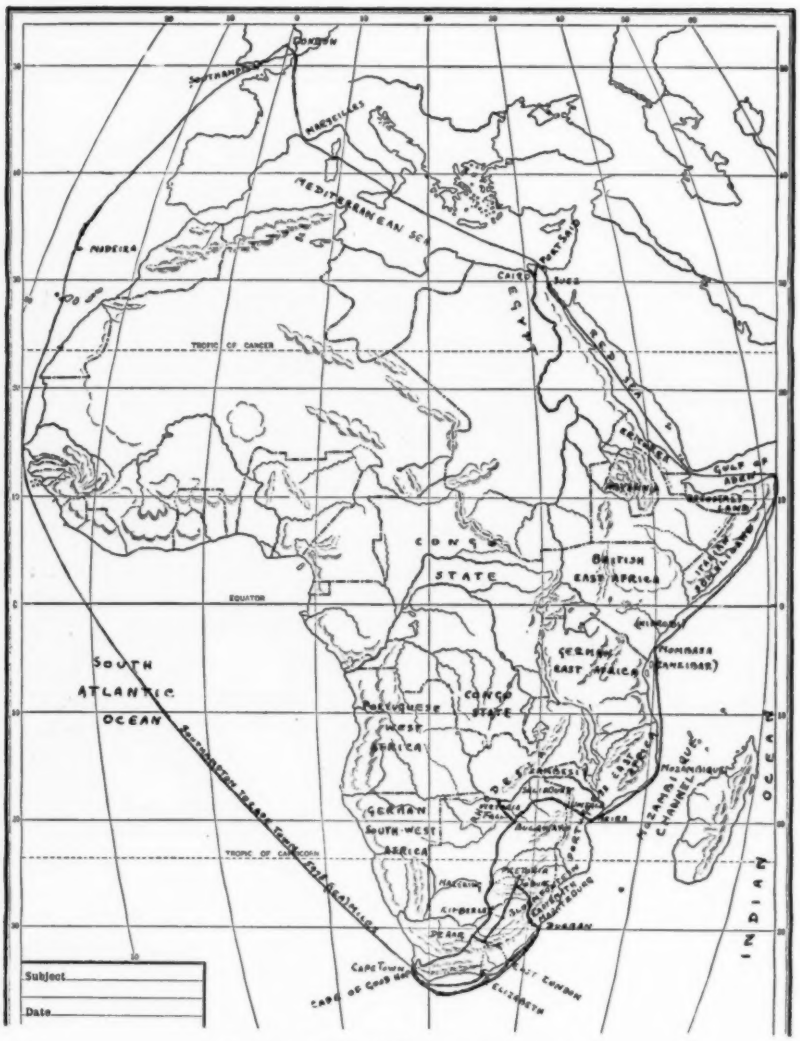
rendered famous during the war; the extension of the main line in Rhodesia to the Victoria Falls made a visit to this natural wonder almost a necessity; and the recent connection of the port of Beira in



SCALE. ABOUT 750 MILES TO THE INCH.

The main routes are marked with a thick line ——
Alternative routes by dotted lines .....
The dot and dash lines ——·— show political boundaries.

This map of Africa is copyrighted by the McKinley Publishing Company, Philadelphia, and is printed here by their courtesy.

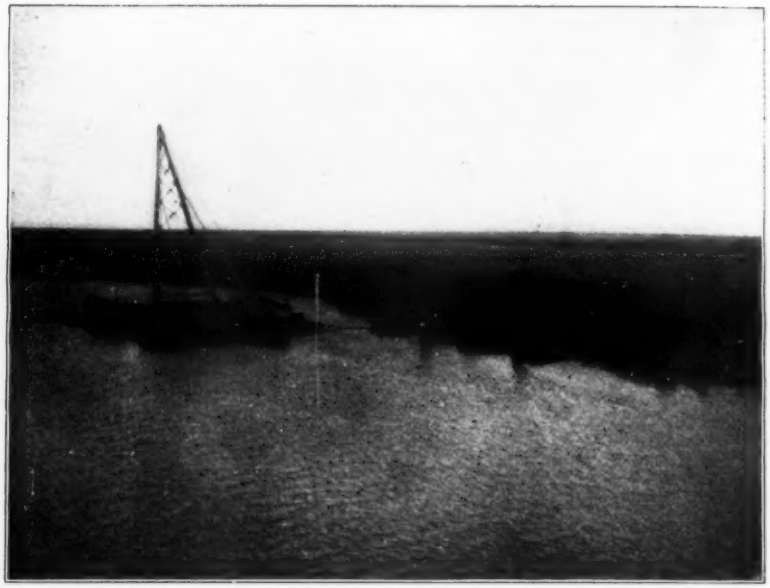
Portuguese territory with Bulawayo suggested a possible return by the east coast and through the Suez Canal.

The tour finally planned was an extensive one, as a glance at the

accompanying map will show. The Union-Castle line steamers *Kildonan Castle* and *Durham Castle,* leaving Southampton on July 22, and the *Saxon,* leaving on July 29, carried the members over the 6,800 miles which separate that port from Cape Town. From there the party traveled by sea or rail to Durban and thence by rail to Johannesburg, making stops at Pietermaritzburg, Colenso and Ladysmith. The scientific meetings were divided between Cape Town and Johannesburg, and four or five days were accordingly spent in each of those towns. After a short visit to Pretoria, the regular program involved a long journey of 1,374 miles to Bulawayo *viâ* de Aar Junction, the only possible all-rail route; on the way, stops of a day or two were made

GENERAL VIEW OF THE VICTORIA FALLS FROM A POINT NEAR THE WEST END.

at Bloemfontein and Kimberley. From Bulawayo five special trains conveyed the oversea party, with the addition of many others living in South Africa, to the Victoria Falls, where a couple of days were spent. On the return to Bulawayo about half the party proceeded direct to Cape Town, whence the regular steamers carried them by the west-coast route to England. The remainder went by rail through Salisbury and Umtali to Beira, where the *Durham Castle* awaited them for the east coast route. On the return journey, Mozambique, Mombasa and Cairo were visited; the presence of plague at Zanzibar and Niarobi upset the arrangements for seeing those two places, but the unexpected block in the Suez Canal enabled the party to spend much more time in Egypt than had been expected. Several members whose duties



THE SPOT IN THE SUEZ CANAL WHERE THE 'CHATHAM' WAS BLOWN UP, causing the Canal to be blocked for over two weeks.

CHARACTERISTIC KOPJES AND A PART OF ONE OF THE RESERVOIRS ON TABLE MOUNTAIN.

called them back early left by the quickest routes from Cairo, many others disembarked at Marseilles, the final port of call, and the remainder proceeded with the ship to Southampton, which was reached on October 24.

The route thus outlined was admirable for seeing as much as possible in the time, thirty-five days, which could be spent in South Africa. But many of those who went out had more specific objects in view than attendance at the meetings or sight-seeing, and arrangements were accordingly made so that any one could deviate from the official route and travel by the ordinary trains. Some went to Durban by the only railway route—through Johannesburg; others omitted Natal altogether and spent the extra time examining the geological and botanical features of Cape Colony and the Orange River Colony; some avoided a great part of the long ride from Johannesburg to Bulawayo by going on 'trek' from Potchefstrom, or from Pretoria, to Mafeking; other parties trekked from Bloemfontein through Paaredeberg to Kimberley; and so on. And in each case something new and definite was to be seen or learnt.

Everywhere the arrangements made by the local committees were admirable. When it is remembered that about 360 people from Europe landed in Cape Town and were carried over an immense extent of territory, were lodged and fed everywhere in comfort and without going through any hardships beyond the fatigue caused by such rapid traveling, and this almost without a hitch of any sort, one can not too highly praise the ability and devotion of all those who were responsible for the organization. And it must be added also that it was not only those who kept to the official route who were alone considered. At every place efforts were made to find out what the various members wished to do and, if possible, arrangements were made to accommodate even a small number; alternative excursions were described in printed circulars, previously distributed, and all that was asked was for each member to apply at the committee room for tickets, so that the number joining any particular excursion might be known. At every place where a stop was made each person knew in advance where he or she was to stay, and conveyances and guides were ready at the station so that there should be no delay or confusion. For example, all that was asked of us at Johannesburg was to stand at the windows of our own compartments as the train steamed into the station, and when the train stopped each host was found standing on the platform opposite his guest. Our baggage, previously directed, arrived later in the day, and meanwhile we were driven, first to the committee room, where we made the circuit of a long counter, gathering up handbooks, tickets and mail, and then to our destinations. And so it was everywhere. No matter seemed too small for consideration and preparation. Many of us felt

that perhaps the most striking feature of the tour was the excellence and elasticity of all the arrangements made for our comfort and convenience. If the ability shown by the colonists in this direction is any guide, one should not fear much concerning the administration of the colonies in the future.

In order to secure the attendance of those whose presence was chiefly desired from the scientific side, a fund of over nine thousand pounds was raised, mainly by contributions from the governments of Cape Colony, Natal, the Transvaal and the Orange River Colony, and supplemented by subscriptions from private individuals; this was used to pay the greater part of the expenses of the 'official members.' The governments also issued free passes over railways to all oversea members, and the Rhodesian railways gave a large number for the use of the official party and tickets at half fares for all others. At those places where a stay was made entertainment was provided for the official party, either in private houses or as guests in the hotels; in some places all the members were similarly treated. Most of the excursions were free to those who chose to take advantage of them. It is a privilege to have an opportunity of saying in public what all of us felt, that the generosity and hospitality displayed by the residents of every town far exceeded our utmost expectations, and the kindness which we received is not likely to be soon forgotten. This too in a land only beginning to recover from the ravages of civil war, suffering from a two years' drought, with nearly all its cattle exterminated by disease, and in the height of the most severe financial depression it has known for twenty years.

The official party, numbering about 180, consisted of the president and general officers of the association, the president, a vice-president and a recorder in each section, a number of prominent scientific men, not necessarily officers, and some younger men of promise and ability selected by the general committee. The ladies who accompanied the official members were also attached to the official party. Finally, representatives of other countries were invited to joint as guests of the association. They included Dr. Backlund, from Russia; Professors Beck, Engler, Harzer and von Luschan, Germany; Professor Böhr, Denmark; Professor Cordier, France; Professor Donner, Sweden; Professor Penck, Austria; Professors Kapteyn and de Sitter, Holland; Mr. D. Randall MacIver, Egypt; Professors Macallum, Coleman, J. B. Porter, Canada; Professors D. H. Campbell, H. S. Carhart, W. M. Davis, W. B. Scott and E. W. Brown, United States; and others who were not able to attend.

The general officers of the association for the year are: President, Professor G. H. Darwin (now Sir George Darwin, K.C.B.); secretaries, Major P. A. Macmahon, Professor W. A. Herdman; treasurer,

Professor John Perry. The presidents of the various sections are as follows: A (Mathematical and Physical Sciences), Professor A. R. Forsyth; B (Chemistry), George T. Beilby, Esq.; C (Geology), Professor H. A. Miers; D (Zoology), G. A. Boulanger, Esq.; E (Geography), Admiral Sir W. J. L. Wharton; F (Economic Science and Statistics), Rev. W. Cunningham; G (Engineering), Colonel Sir C. Scott Moncrieff; H (Anthropology), Dr. A. C. Haddon; I (Physiology), Colonel D. Bruce; K (Botany), H. W. T. Wager, Esq.; L (Educational Science), Professor Sir Richard C. Jebb. Amongst others who attended and who are not included in the above lists or in the list of lecturers given below may be mentioned Sir Benjamin Baker, Sir T. Lauder Brunton, Professor John Milne, Dr. J. A. H. Murray, Sir W. H. Preece, the Earl of Rosse, Alexander Siemens, Esq., and Dr. A. Traill, provost of Trinity College, Dublin.

II.

To one accustomed to the rush of the high-speed boats on the north Atlantic, the rows of huddled up and miserable passengers lying in deck chairs, the cold winds and the frequent bad weather, a journey in a mail steamer crossing the equator presents a pleasing contrast. There is a general air of sociability and comfort; sports, tournaments

SOME OF THE MEMBERS ON THE 'SAXON' before the ship left Southampton. In the top row, reckoning from the right, may be seen Prof. and Mrs. Herdman, Prof. Forsyth, Mr. Freshfield, Sir R. Jebb, Sir W. Wharton, Dr. Murray; in the second row, Dr. Haddon, Professor Perry, Sir W. Crookes, Sir L. Brunton, Major Macmahon, Mrs. Darwin; in the third row, the writer, Professor Darwin and Professor Sollas.

and entertainments of all kinds are of daily occurrence; and to these diversions were added in our case, as befitted the character of the company, lectures and discourses on subjects which were generally connected with the countries to be visited. But perhaps the most useful feature of the voyage was the opportunity it afforded for the leisurely discussion of scientific and professional matters and for establishing closer personal relations between men representing various departments of science. It need hardly be said that this was very fully appreciated, especially by those who have their work in places remote from the main centers of intellectual activity.

EUPHORBIA 'SNAPPED' FROM THE TRAIN NEAR DURBAN.

The southern gateway of Africa is an imposing sight as it is approached from the sea. A characteristic feature of the mountains, the table-like formation with high vertical cliffs on one side, has no better example than the huge mass which faces Table Bay, flanked on one side by the conical hill known as the Lion's Head, and on the other by the Devil's Hill. Cape Town lies on the low ground in front of the mountain and one can not see the old and new fortifications guarding the entrance to the docks without remembering its early settlement by the Dutch, its later acquisition by the English and the fact that, until the completion of the railways to Durban, Delagoa Bay and Beira, the story of South Africa is almost contained in that of Cape Town. All through the late war it was the principal port of entry for men and supplies and during that time was a scene of tremendous activity. It is now suffering from severe depression caused by over-speculation

in building and commerce. In spite of the fact that the population of the whole colony is less than 600,000 whites, trading was started after the war on a scale which a white population of twenty millions would hardly have justified. As might be expected in a town of nearly 80,000 inhabitants, Cape Town has the conveniences of a modern city, a fine town hall just finished at a cost of a million and a quarter dollars, a good and plentiful water supply, electric light, extended railway and trolley car lines, and a perfect sewerage and drainage system.

It is not possible for me to warn intending tourists of the troubles caused by quarantine, customs declarations, passports or baggage transport, for all these formalities were dispensed with: we had only to walk ashore in company with our hosts who had come on board the ship to meet us. The first half of the presidential address was delivered by Professor Darwin on the evening of arrival, and the following three mornings were devoted to the sectional meetings. The five days in Cape Town were spent by the different members of the party in different ways, according to their consciences or inclinations. The afternoons were generally free for excursions, and the evenings were fully occupied by receptions or lectures, well attended by both visitors and residents. Many of the geologists were attracted by the opportunity to see the country with their own eyes and obtain data for the discussion of those problems which appear to be peculiar to South Africa. The astronomers were particularly active both in Section A and in afternoon and evening visits to the observatory, the history of which furnishes remarkable examples of devotion to science; under the present director it has not only been equipped with some of the finest and most modern instruments, but has sent forth many valuable contributions towards our knowledge of the heavens. Groote Schuur, the residence of Cecil Rhodes and bequeathed to the colony at his death, was a center of interest as the home of the man 'who thought in terms, not of countries, but of continents,' and nearly every one visited the beautiful house and extensive estate with its large collection of African animals. On the last day some hundred and fifty of the party, guided by members of the Cape Mountain Club and others, climbed up various routes on to Table Mountain and sat down to a lunch provided by the mayor near the new reservoirs which supply the city with water. There were excursions also to various features of interest in the town and its neighborhood, to the De Beers Explosive Works, to the Government Wine Farm at Groot Constantia, to the Admiralty Works at Simonstown, and to the Elsenburg Government School of Agriculture at Stellenbosch.

III.

The southeast coast railway to Durban is as yet incomplete and, to avoid the long railway journey *viâ* Johannesburg, the members left

Cape Town by the *Saxon* on August 18, calling at Port Elizabeth and New London, or by the *Durham Castle,* leaving the following evening and going direct to Durban. The times were so arranged that every one arrived there on the morning of Tuesday, August 22. There is practically only one good natural harbor for ships of large tonnage on the east coast of South Africa—that of Delagoa Bay, in Portuguese territory. Much money has therefore been spent in improving the harbor at Durban by building a long mole and by dredging the shallow channel which leads into a large protected lagoon. It is now possible for the mail boats to go inside and tie up alongside of the quays. One

THE CHIEF PRINCESS OF THE TRIBE WHICH GREETED THE PARTY AT MOUNT EDGECOMBE.

was struck immediately on landing by the mixture of the east and the west. Jinrickshas drawn by Zulu boys with their picturesque headdresses, ordinary two-horse carriages, and electric cars on the trolley system carried the passengers along well-made roads bordered by trees, to private houses and hotels, where they were waited on by Indian servants. Shops of all kinds, a big department store, English churches and chapels, a synagogue, a mosque, three-storied residences, bungalows—all these made it difficult for us to realize that we were in a town which has been British territory since its foundation in 1823. As at Cape Town, there were receptions, lectures and excursions to the more interesting works of nature and man. There were only two days allotted to Durban and the majority of the party spent the greater part of one of them at Mount Edgecombe, some fourteen miles away, where the factory of the Natal Sugar Estates is situated. The company had

issued an invitation for lunch and an inspection of its works, and it had also made arrangements for us to see something of the native element by gathering together over 300 Zulus from the surrounding country. The exhibitions of war and other dances which we witnessed were much appreciated by the ethnologists and photographers. I may mention here that over a hundred cameras were continually employed on all varieties of subjects throughout the whole of the trip. In order that a record of some permanent value may be obtained, it has been proposed to make a selection of photographs taken by those who are willing to lend their negatives and to publish a memorial volume containing the best of the pictures.

THE BRIDE, BRIDESMAIDS AND INDUNA. Mr. Samuelson is standing on the right.

An even more interesting view of native customs was obtained in an excursion to the large Henley reservation near Pietermaritzburg, our next resting place. Maritzburg, as it is generally called, lies in a basin surrounded by hills and is laid out on the Dutch plan, in blocks like an American town, with broad avenues, but with houses which, like most of the residences in South Africa, are only of one story. The reservation is on higher ground and the station is less than ten miles away as the crow flies, but requires a journey of seventeen miles along a railroad with steep grades and sharp curves. The only white man living on the reservation is the permanent undersecretary for native affairs, Mr. Samuelson. By his wish, the marriage ceremony of one of the native chiefs, Mhlola, the head of the Inadi tribe, had

STREET IN MARITZBURG.

A VISITOR DURING A HALT BETWEEN MAFEKING AND BULAWAYO.

been postponed in order that the association might have the opportunity of witnessing it. The bride, who is to be Mhlola's chief wife, is a 'commoner,' contrary to the usual custom. It is probably the only occasion that a royal Zulu wedding has been attended by a large party of invited guests of the white race. We watched the official part of the ceremony for some three hours; dances, speechmaking and chanting of war-songs not unlike Gregorian chants occupied most of the time. The part of the ceremony which constituted a legal marriage was followed by the presentation of gifts from the bride to her husband's principal female relatives and of symbolical presents to the bridegroom consisting of a lamp, a water jug, basin and soap, a chair and an umbrella. The festivities were to last two or three days, but the members of the association had to leave for other scenes, and they preferred the conventional lunch provided by the residents of the city to the oxen roasted over open wood fires and the Kaffir beer in which the natives delight. This attractive program occupying the only full day spent at Maritzburg prevented many of the visitors from joining in the numerous other excursions which the hospitable residents had arranged. Some idea of our activity throughout the trip may be gathered from my movements on the previous day. Leaving Durban at 8:50 A.M. and reaching Maritzburg at 1:10 P.M., I spent the early afternoon in riding round on the electric cars, seeing the town and visiting the new botanical garden. Then to a garden party at Government House, and after dinner to a lecture on 'Sleeping Sickness,' by Colonel Bruce!

It was a fortunate circumstance that the third volume of the *Times'* history of the Boer war, containing a full account of the operations round Ladysmith, should have been published early in the year. Those who had read it during the outward voyage were able to picture to themselves the various incidents of the struggle as the trains slowly steamed through the area past Estcourt, Frere and Chiveley, to Colenso. An afternoon was spent in climbing the nearer hills of Fort Wylie and Hlangwani, and in viewing the devious course of the Tugela as it threads its sunken bed through the rolling ground lying in front of the round-topped hills which faced the army at Colenso. Stone sangars, but little damaged, are still to be seen on every hand, but the hunters of curios in the shape of bullets and portions of shells had done their work too well long before our arrival, and few relics were discovered. Here the special trains were side-tracked for the night so that the points of interest along the short distance to Ladysmith could be seen by daylight. The residents of this quiet country town lying in a warm hollow on the Klip River had gathered together every available private and public conveyance and drove us to the scene of the most famous incident of the siege, Wagon Hill. This spot, about

three miles from the town, commands it completely, and had the Boers in their determined attempt on January 6, 1900, succeeded in capturing the hill against the desperate defense made by the British, it would have been necessary to retake it at all costs or to evacuate Ladysmith. Another hill of historic interest, Spion Kop, some eighteen miles distant, was visited by a small party who had gone on ahead for the purpose. The town itself bears few marks of the siege. The hole made by a shell in the clock tower of the town hall is still unrepaired, doubtless for the sake of tourists. I noticed the remains of a few of the 'dug-outs' in the steep crumbling banks of the river, and some of the corrugated iron plates which form the walls of a freight shed at the railway station had many bullet-holes in them; they had been evidently used for cover and returned at the end of the siege.

The day at Ladysmith was followed by a night's journey to Johannesburg. The higher veld is reached along a series of heavy grades, frequently one in thirty. There is no attempt to make the line straight; tunnels, embankments and cuttings have been avoided as far as possible to save expense, and the line, especially over rolling plains, closely follows the natural level of the land. Over a thousand feet of height is gained near the border of the Transvaal by a series of zigzags up the side of a mountain; at each of these the line comes to a stop, and the train is reversed up the next portion, and then forward again after another stop. There is apparently no hill around which the line may curve easily in order to obtain the desired height.

IV.

Although Johannesburg has been so often described, I can not pass in silence over this focus of all the later development of the Transvaal and of most of its political difficulties during the last twenty years. Moreover, so many changes have taken place since the war ended and so much misconception still prevails about the conditions there that it is only right and perhaps not uninteresting to record the impressions of one who was anxious to learn the facts and who had various opportunities for obtaining accurate information at first hand. The most striking and noteworthy of these impressions was the absolute openness of everything connected with the mining industry. Not only have very full reports of the working of each mine to be sent in monthly to the government and to the Chamber of Mines, but every new process, every improvement in machinery, every new problem arising, every difficulty occurring in the management of the natives and Chinese, is known or can easily be found out by those living on the Rand. And this is true not only of the residents, but also of any visitors who may wish to learn the facts and will go to the proper sources for them. In our case, the chief desire seemed to be that we should get to know

what the actual conditions were, the bad as well as the good side; it was not a question of searching for information, but of listening to the full answers which an enquiry always produced. In particular, the native and Chinese compounds were visited at all hours both with and without previous notice. My own impressions and those of our party with whom I afterwards talked were the same: that the arrangements for housing and feeding the workers are far better and more complete than we had any idea of, and that the slavery which has been and is still so much exploited in meetings and newspapers of a certain class does not exist. Passes for leaving the compounds during off hours are freely granted to natives and it is only since the commission of crimes outside by a few bad characters that a restriction in this direction has been placed on the Chinese. As one walked about the compounds or in the mines underground the solemn Chinese equally with the light-hearted native readily responded to a word or a smile. 'Tell those who abuse us to come and see things for themselves'—was a frequent remark from the mine officials with whom I talked.

A second striking feature is the change which must have come over the spirit of the so-called 'Outlander' since the conclusion of the war. Formerly, Johannesburg consisted of the business section, the mines with compounds for the natives, and cottages on the mining area for the staff and white workers. During the last three years large suburbs have sprung up with many hundreds of residences surrounded by gardens and young trees, and having every appearance of permanent occupation. If this conclusion is correct, there will be a large settled population within the city area which will take an interest in its future and in the general affairs of the country, in spite of the fact that the majority of the shares of the mining companies are naturally owned in Europe, whence came the money which started them. To this must be added the consideration that nearly all the best work on the mines is being done by comparatively young men who have gone to them with the definite intention of making a living, and who have to use all the ability and energy they possess to rise to the higher positions. There is need now, however, of men of a higher grade, with, if possible, a college education and special training in some one or more of the departments connected with mining.

As might be expected, the town gives every external appearance of being alive. But it presents some curious anomalies. One has not to walk far from the principal streets with fine buildings on either side, shops, offices, clubs and hotels, to reach old shanties which look as if they had been there at the opening of the Rand. Cabs, carriages and automobiles are passing rapidly along the roads (there is no speed limit!), but there is only a single line of slow horse-cars. Instead of a modern sewerage scheme the 'bucket system' is employed. Electric

light is furnished by the municipality, but about two thirds of the current has to be purchased. It is only right to state that all these defects are being remedied at a large outlay of money, and the rates are going up at a speed which may give cause for jealousy in certain cities of the northern hemisphere. It is to be remembered that Johannesburg is only eighteen years old and that for four of these years it had to lie fallow, although it practically escaped damage. I must pass over the many interesting features of the social conditions which the society of the place has evolved.

The scientific meetings of the association, begun at Cape Town, ended with the stay in Johannesburg. Many of the papers naturally dealt with problems and matters relating to South Africa; especially was this the case in the chemical and engineering sections during the latter half of the meeting. I shall not attempt to give any *résumé* of the work done; accounts will be found elsewhere. Professor Darwin's presidential address on the evolution of matter was delivered in two halves, one at Cape Town and the other at Johannesburg. It excited great interest for its own sake and also as continuing the connection between the name he bears and the subject which first gave it world-wide fame. The many illustrated evening lectures on a great variety of subjects were a special feature throughout the tour; some of them had been prepared at the cost of much time and money, and, judging by the attendance, were very fully appreciated by those who heard them. The list included the following: 'W. J. Burchell's Discoveries,' by Professor Poulton, and 'Surface Actions of Fluids,' by Professor Vernon Boys, in Cape Town; 'Mountains of the Old World,' by Mr. Douglas Freshfield, and 'Marine Biology,' by Professor W. A. Herdman, at Durban; 'Sleeping Sickness,' by Colonel D. Bruce, and 'The Antarctic Regions,' by Mr. H. D. Ferrar, at Maritzburg; 'Distribution of Power,' by Professor Ayrton, and 'Steel as an Igneous Rock,' by Professor J. O. Arnold, at Johannesburg; 'Fly-borne Diseases, etc.,' by Mr. A. E. Shipley, at Pretoria; 'The Milky Way and the Clouds of Magellan,' by Mr. A. R. Hinks, at Bloemfontein; 'Diamonds,' by Sir W. Crookes, and 'The Bearing of Engineering on Mining,' by Professor J. B. Porter, at Kimberley; 'Experimental Farming,' by Mr. A. D. Hall, at Mafeking; 'Rhodesian Ruins,' by Mr. Randall MacIver, at Bulawayo.

(To be continued.)

THE FOUNDATIONS OF GEOMETRY

AN HISTORICAL SKETCH AND A SIMPLE EXAMPLE

By Dr. OSWALD VEBLEN,
PRINCETON UNIVERSITY

GEOMETRY as a logical system took its first definite form in the mind of Euclid (about 330–275 B.C.); and since the edifice constructed by the grandfather of geometry has justly retained the admiration of all succeeding students, one can perhaps exhibit the modern researches on the same subject in no better way than by contrasting them with some of Euclid's fundamental statements. The propositions which Euclid placed at the foundation of his work have come to us classified under three heads: definitions, postulates, axioms. As examples of the first we may quote (from Todhunter's edition).

1. A point is that which has no parts, or which has no magnitude.

2. A line is length without breadth.

3. The extremities of a line are points.

4. A straight line is that which lies evenly between its extreme points.

5. A superficies is that which has only length and breadth.

7. A plane superficies is that in which, any two points being taken, the straight line between them lies wholly in that superficies.

15. A circle is a plane figure contained by one line, which is called the circumference and is such that all lines drawn from a certain point within the figure to the circumference are equal to one another:

16. And this point is called the center of the circle.

It is evident that in the first of these statements, if 'point' is defined, 'magnitude' or 'parts' is not; in the second, if 'line' is defined, 'length' and 'breadth' are not; and so on. A partial list of the terms undefined in the above definitions would include magnitude, length, breadth, extremities, lie in, lie evenly, equal to. It is in fact a commonplace among teachers and schoolboys that to any one who did not already know what the terms meant, these definitions would be entirely meaningless. Another way of stating the same proposition, and the way upon which modern mathematicians insist, is that in every process of definition there must be at least one term undefined. A thing which is not defined in terms of other things we may call an *element*.

It is also to be observed that in the above list of undefined terms there are at least two classes to be distinguished. The first four terms are nouns and correspond to the notion *element*. The last three are

verbs, are conjunctive of elements, and correspond to the notion *relation*. You observe that no formal definition is here made of the words element and relation. I simply try to call up a distinction which I suppose to exist in the reader's mind.

The postulates and axioms of Euclid are so little to be distinguished from each other that in various editions some of the postulates are put among the axioms. The axioms (common notions) were regarded by Euclid's editors and the world at large, if not by Euclid himself, as a list of fundamental truths without granting which no reasoning process is possible. It was nearly as great a heresy in the middle ages to deny Euclid's axioms as to contradict the Bible. Without emphasizing further the historical fact that the axioms were regarded as necessary *a priori* truth, nor the fact that this belief is now largely outgrown, I wish to call attention to a mathematically more important feature. If the axioms are necessarily true, and if they are to be used in proving all things else, they themselves are not capable of demonstration. For mathematical purposes, the axioms are a set of *unproved propositions*. Out of Euclid's definitions and axioms we therefore select for emphasis the presence of

1. Undefined terms { relations. / elements,
2. Undemonstrated propositions.

The postulates of Euclid are as follows. Let it be granted,

1. That a straight line may be drawn from any one point to any other point.
2. That a terminated straight line may be produced to any length in a straight line.
3. And that a circle may be described from any center, at any distance from that center.

His axioms state:

1. Things which are equal to the same thing are equal to one another.
2. If equals be added to equals the wholes are equal.
3. If equals be taken from equals the remainders are equal.
4. If equals be added to unequals the wholes are unequal.
5. If equals be taken from unequals the remainders are unequal.
6. Things which are double of the same thing are equal to one another.
7. Things which are halves of the same thing are equal to one another.
8. Magnitudes which coincide with one another, that is, which exactly fill the same space, are equal to one another.
9. The whole is greater than its part.
10. Two straight lines can not enclose a space.
11. All right angles are equal to one another.
12. If a straight line meet two straight lines, so as to make the two interior angles on the same side of it taken together less than two right angles, these straight lines, being continually produced, shall at length meet on that side on which are the angles which are less than two right angles.

Modern objections to these axioms are to the effect that most of them are too general to be true, that 2, 3, 4, 9, for example, are not valid in every case where we use the term equality; that the axioms are insufficient in that Euclid uses assumptions not explicitly stated, etc. But our present interest in looking for such faults is not great.

Of all the axioms and postulates, the last is by far the most remarkable and important historically. One is led from internal evidence to believe that Euclid introduced it only after failing to make his proofs without its aid. It is not used before proposition 29, not even in proposition 27 which states that if one line falls on two others

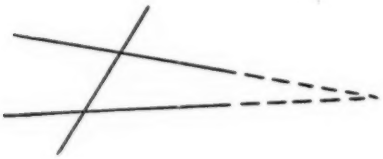


FIG. 1.

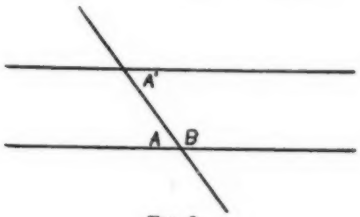


FIG. 2.

so as to make the 'alternate interior angles' (A and A') equal, then the lines are parallel, *i. e.*, do not meet. In proving the converse statement (29), however, he found it necessary to assume that if the sum of the two angles A' and B is less than two right angles the lines will meet when produced far enough. This assumption is axiom 12.

It is perhaps worth while to add that the parallel axiom of which we are speaking may also be stated in the form: 'Through a point, A, in a plane, α, not more than one line can be drawn which does not intersect a line, a, lying in α but not itself passing through A.' The thirty-second proposition, to the effect that an exterior angle of a triangle is equal to the sum of the opposite interior angles, may also be used in place of axiom 12.

The twelfth axiom of Euclid was a stumbling block to many philosophers and mathematicians. While they were ready to grant that they would not be able to reason logically without the other axioms, this one seemed somehow less evident and less fundamental. The natural first attempt was to construct a proof for the axiom so as to give it place as a theorem. Many so-called demonstrations have been offered even up to the present day, but none that have withstood examination. At last, however, the thought came, "what if this axiom were not true? What would become of geometry if axiom 12 were replaced by a new axiom directly in contradiction with it?" It was found that by reasoning based on the reverse of axiom 12 one could involve himself in no contradiction, that, on the contrary, there re-

sulted a new edifice of science which, while different from the old and containing many a strange proposition, yet never denied itself nor violated any of the principles of logic.

These results were obtained first by an Italian Jesuit priest named Saccheri and timidly published in 1733. His work, however, has been known to the modern world only very recently. The non-Euclidean geometry was rediscovered by a Russian, Lobatchewsky (1826), and a Hungarian, Bolyai (1832), though their work also remained unknown to the world at large till 1866 when it fell under the notice of the German mathematician Baltzer. The investigation of the parallel axiom has been continued by Riemann, Beltrami, Helmholtz, Sophus Lie, Cayley, Klein, until it may fairly be said that, ten years ago, this twelfth axiom of Euclid which had at first seemed such a stumbling-block was better understood than any other of his definitions and axioms.

The next attempt after Euclid's to consider geometry as a whole from a purely synthetic point of view was made by a German, Moritz Pasch. His theory, delivered first in a course of lectures in 1873–4, was published in a book called 'Neuere Geometrie' in 1882.

The advance of Pasch beyond Euclid consists essentially in the clear perception of the notions *undefined element* and *unproved proposition*. In other words, he tries to state sharply just what concepts he leaves undefined and does reduce the number of these much below that of the elementary concepts employed by Euclid. He distinguishes between his definitions and axioms. He aims to include in his axioms every assumption that he makes.

His undefined elements are 'point,' 'linear segment,' 'plane surface.' These, according to the axioms, have relations such that a point may be *in* a segment or a surface, a linear segment may be *between* two points (called its end-points). There is also introduced a relation called congruence (geometrical equality) of figures which corresponds to the Euclidean idea of superposition. We will quote only a few of Pasch's axioms, since they can not signify much apart from the propositions developed out of them.

1. Between two points there is always one and only one linear segment.

2. In every linear segment there is a point.

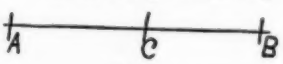


FIG. 3.

3. If a point *C* lies in a segment *AB*, then the point *A* does not lie in the segment *BC*.

4. If a point *C* lies in a segment *AB*, then so do all the points of the segment *AC*.

5. If a point *C* lies in the segment *AB*, then no point can lie in *AB* which does not lie in *AC* or *CB*.

Out of these assumptions about the relations between points and line segments, together with three other axioms, Pasch deduces the

usual propositions about the order in which points lie on a line; the complete line and order itself being defined in terms of the elements and relations mentioned above. He then introduces the plane surface by means of some further axioms, among which are:

1. Every three points are in a plane surface.

2. If a line segment lies between two points of a plane surface there is a plane surface in which lie all points of the given plane surface and also all points of the line segment.

4. If *A*, *B*, *C* are three non-collinear points of a plane surface and any segment *DE* of the surface has a point in common with one of the segments *AB*, *BC*, *CA*, the line *DE* has a point in common with one of the other segments or one of the points *A*, *B*, *C*.

This fourth axiom of Pasch is the one that is generally regarded as having required the greatest insight and is most often associated with his name.

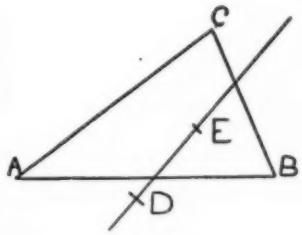


FIG. 4.

A very great improvement over the work of Pasch was made by the Italian mathematician, Peano, who published in 1889 his 'I Principii di Geometria.' The undefined terms of Peano are the elements *point* and *segment* and the relations *lie on* and *congruent to*. The plane segment of Pasch is defined as a certain set of points.

In Italy, at this time, there was beginning a great revival of interest, largely due to the influence of Peano, in the purely logical aspects of mathematics. This has resulted in a large number of investigations not only of the foundations of geometry, but of mathematics in general. The results are mainly expressed in terms of symbolic logic and proceed a long way toward solving the problem to obtain the smallest number of undefined symbols and unproved propositions that will suffice to build up geometry. Besides Peano one needs to mention chiefly Pieri, who has investigated projective geometry and also the possibility of basing elementary geometry on the concepts, *point* and *motion*. Standing aside from the pasigraphical school of Peano, there is Veronese, who has done pioneer work in connection with the axioms of continuity.

In Germany the chief figure at present is D. Hilbert, whose book on 'Foundations of Geometry' (1899) has been translated into several languages, including English. Hilbert's work is the first systematic study that has received widespread attention, and he has therefore been credited with originating a great many ideas that are really due to the Italians. Hilbert's chief contribution to the foundations of geometry is his study of the axioms needed for the proof of particular theorems which he has collected in the latest edition of his book.

The above historical account has no doubt many important sins of omission besides those due to its brevity. But for the purpose of grasping the type of thought involved in these researches further general remarks would probably be less useful than a simple example.

In the academic year 1890–1 Professor C. Segre gave a course of lectures at the University of Turin in which he studied the analytic geometry of n dimensions. A point of n-dimensional space he defined as usual to be a set of $n + 1$ homogeneous coordinates $(x_1, x_2, \cdots x_{n+1})$, a line as a set of points satisfying a set of linear equations, etc. To his students, however, he proposed the following problem:

To define a space *Sn* not by means of coordinates, but by a series of properties such that the representation with coordinates can be deduced as a consequence.

In other words, he asked for a set of axioms for n-dimensional space. The problem was taken up by one of the students, Gino Fano, now a professor at Turin, and the results published in the *Giornale di Mathematiche*. I wish to reproduce one of the many interesting constructions that Fano obtained and to illustrate by means of it certain concepts that have grown up since then.

Let us take the case of n-dimensional geometry where $n = 2$ and proceed for a time as if to build the projective geometry of the plane. Let our undefined elements be called *points* and let us speak of certain *undefined* classes or sets of points which shall be called *lines*. Every one will recognize as valid of projective geometry the following propositions which are our axioms—our unproved propositions.

1. **If *A* and *B* are points there is one line which contains them both; and**
2. **There is not more than one such line.**
3. **Any two lines have in common at least one point.**
4. **Not all the points are on the same line.**

If we stop at this point and try to see how much we can prove on the strength of our assumptions, we are confronted at once by the fact that we can not prove the existence of even a single point. This must therefore be assumed by a further axiom. The assumption of one point is not enough either, but if we assume that there are two points, it follows from 4 that there must be at least three. There need not, however, be more than three, for if we suppose that the points referred to are A, B, C, and that the line AB consists merely of the points A and B, the line BC of the points B and C, and the line CA of the points C and A, then on rereading 1, 2, 3, 4 it is evident that they are all satisfied. Hence in order to get ahead we must assume:

5. **In each line there are at least three points.**

But this does not postulate the existence of even a single point till we add

6. There is at least one line.

We are now in a position to develop considerably more theory. By 6 and 4 and 1 there must be at least two lines which by 3 meet in a point A. Hence there must be four points at least, (B, C, D, E) which do not lie in the same line. For if D were in the line BC, by 2, the lines AB and AD would be the same, which is contrary to hypothesis.

A set of four points, such as A, B, C, D, of which no three are collinear, when taken together with the lines (called the *sides*) joining the six pairs of points, AB, BC, CD, DA, AC, BD, is called a complete quadrangle. In the diagram below, the vertices of a complete quadrangle are 0, 1, 4, 6. The three additional points 2, 3, 5, in which the sides of the quadrangle intersect, are called the diagonal points.

We have shown our axioms sufficient to establish the existence of a complete quadrangle; are they sufficient to prove the ordinary properties of such a figure? They are not. Axioms 1–6 do not decide whether the three diagonal points, 2, 3, 5, are or are not collinear. In the ordinary geometry, those points are non-collinear and form what is called the diagonal triangle. If, however, we suppose that they are collinear (one may assist one's imagination by means of the dotted line) then on rereading our six postulates they will all be found verified. In order to obtain the usual geometry it is necessary to assume *as an axiom* that the diagonal points of a complete quadrangle are non-collinear.

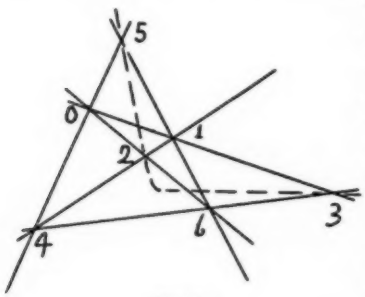


FIG. 5.

What we have just done is a simple case of an 'independence proof.' We have proved that the proposition that the diagonal points of a complete quadrangle are not collinear, is independent of propositions 1, ··· 6, that is, it is not a logical consequence of them. Similarly, the non-Euclidean geometry is an independence proof for Euclid's axiom 12. The ideal of students of foundations of geometry is a system of axioms every one of which is independent of all the rest. To attain this ideal it is necessary to construct for each axiom an example in which it is untrue while all the rest are verified.

After seeing the bizarre construction that this process gives rise to, one is tempted to raise the question, how can we be sure that the complete system which we use applies uniquely to the space of our intuition or experience and not also to one of these mathematical dreams? In answering this question we define what is meant by a *categorical* system of axioms.

Returning to our complete quadrangle with collinear diagonal points

and observing the numbers placed at its vertices, we may arrange in the same column the numbers of the points that appear together in the same line.

0	1	2	3	4	5	6
1	2	3	4	5	6	0
3	4	5	6	0	1	2

The array thus obtained is known as a 'triadic system' in the seven digits 0, 1, ··· 6.

If the undefined element, 'point' of our axioms is any one of the digits 0 ··· 6 and 'line' is a column, then the six axioms incompletely describe the triadic system. They describe it completely if we add:

7. There are not more than three points on a line.

I say they describe it completely because we have proved that the axioms are satisfied by seven points arranged as in the triadic system, while from 7 it follows that no other arrangement or number of points is in harmony with the axioms. There is only one kind of thing which satisfies all the axioms 1 ··· 7. In other terms, any two systems of objects (for example, the points of the diagram on p. 28, and the triadic system on p. 29) that satisfy axioms 1 ··· 8 are reciprocally in a one-to-one correspondence which preserves all the relations of the kind specified in the axioms.

This is what is meant by a categorical system of axioms. Thus in geometry, a categorical system is capable of distinguishing Euclidean space from all essentially different constructions of the mind—and this in spite of the fact that the fundamental elements of geometry are never defined in the ordinary sense of the term definition.

If we have before us a categorical system of axioms, every proposition which can be stated in terms of our fundamental (undefined) symbols either is or is not true of the system of objects satisfying the axioms. In this sense it either is a consequence of the axioms or is in contradiction with them. But if it is a consequence of the axioms, can it be derived from them by a syllogistic process? Perhaps not.

THE CONTENT OF CHINESE EDUCATION[1]

BY CHARLES KEYSER EDMUNDS, PH.D.,
CANTON CHRISTIAN COLLEGE

THAT China is at present in a state of transition along all lines, but especially in educational matters, is patent to all observers. To-day we should distinguish between the old China and the new China. In order to understand the transition now under way we must, of course, consider the forces that have made and characterize the old China. Of these none has had greater influence than the system of literary examinations by means of which civil servants have long been selected. To place this examination system in proper perspective, it is necessary first to notice the characteristics and content of elementary and preparatory education.

It seems, though the records are sufficiently mythical, that as early as 2400 B.C. there were family, town and county schools throughout the empire, but then as now they bore no relation to either the national, provincial or district government. The only national schools have been those for Bannermen, originally on a liberal scale, but now neglected. In various places provincial officers have from time to time opened schools for military, naval or special purposes. Chinese 'colleges,' so-called, are merely advanced schools of grammar, rhetoric and fine writing.

In the primitive period books were few and the youth depended on oral teaching, and the schools in eastern Asia as in western Asia and Greece were ambulatory. Though at a great disadvantage in the matter of libraries as compared with modern students, there were several compensating circumstances which made the ancient schools superior as formers of character, for practical morality was the great object, and intellectual discipline ranked subordinate. In such work the character of the teacher was the prime factor, and the question-and-answer method forced on them by the lack of books excited inquiry and fostered originality. Now only the forms and names of this period remain without the reality.

While there is not and practically never was a school system in China, a method of instruction has prevailed, not only very ancient,

[1] Chinese education of the type described in this article has been abolished by imperial edict of September 2, 1905; but as yet the actual transformation has not progressed far enough to justify the use of the past tense.

but proceeding from and at the same time in great part responsible for those characteristics which mark the Chinese under every variety of physical condition. The cast-iron nature of this method has in several hundred years wasted enough energy for ten millenniums of true education, and this has made China what she is to-day. But the walls are breaking down—such a state can not longer endure.

We purpose to sketch the essentials of this method, and later on to notice the renovation it is experiencing under the influence of western thought and life. Although the Chinese classics have often been reviewed, we shall nevertheless treat the subject matter of Chinese education in some detail, so that we may better appreciate the change that is taking place. Free use of the material afforded by Legge, Williams, Martin, Giles, Smith and Lewis will be made, and our only excuse for taking our own wherever we may find it will be that we shall try to borrow with good judgment.

China's youth are denied that domestic training which is the heritage and boon of western childhood, and so are tremendously handicapped at the very start. After seven or eight years of vegetation a Chinese child is put under the family or clan preceptor or, clad in festal robes, starts for the village school, which is maintained either on a semi-private basis by several families together, or under the patronage of philanthropic gentry, who are liberal enough, but do not always see that the schools are efficiently conducted. The central government bestows imperial honors on benefactors of schools; but having no root in the revenue of the state, Chinese education affords even the most elementary schooling to only a small fraction of the youth of the land.

Improper school-rooms, long hours of study, excessive restraint, frequent absences, but no inspiriting vacations, a severity in the teacher that sometimes reaches barbarism, and utter neglect of physical culture and hygiene, all combine in the predominant type of Chinese school to render the students much below par physically. Nor is the 'infanticide' less intellectual than physical. In all grades the mode of acquisition is the same: imitative and servile. The mental vitality which this ancient people have retained is not by reason of their education, but in spite of it. A real scholar in China is the survivor of hundreds who have failed.

There is no pedagogy in the old China, any one who has learned is deemed competent to teach, for there is only one way, *viz.*, as Dr. A. H. Smith has described, to set each pupil a 'stent' by showing him what sounds to utter and then for each student to bawl out his characters at the top of his voice. When the lesson is 'learned,' that is when the scholar can howl it off exactly as the master has pronounced it, he stands with his back to the teacher and repeats (or 'backs') the

lesson in a loud singsong until he reaches the end of his task or of his memory, when his voice suddenly drops from its high key like a June beetle striking a wall. The stimulus of companionship in study is denied, each pupil memorizes, recites and writes in a class by himself, even though many may be engaged on the same passages.

The preceptor is seldom over diligent. Without any personal interest save in the exceptional student, he simply keeps the mill going and is not expected to modify either the curriculum or the method of instruction. There is no variety, no adaptation to pupil, no room for pupil-judgment—only attention cultivated so highly that he can study without diversion amid the greatest din. The scholar must develop 'phonographic' abilities of memory; if not, there is no remedy except the rod. Recent native schools along more modern lines have swung to the other extreme and are entirely too lax, and there have been many instances in which the student body has presumed to run the school. The aversion to the old-style severity of the native teacher has been a primary cause of the frequent rebellions in foreign schools in China when a stand for faculty-power in proper discipline has had to be firmly though kindly taken.

Sons of shopkeepers and farmers and others who do not expect to enter the lists for literary honors, but merely to acquire a moderate proficiency in the native language, are put through a three- or four-year course in six elementary classics which the aspirant for a degree usually skips, beginning at once with the 'Four Books,' which may be studied also by the more clever of the lower class. Thus the literary graduate who turns pedagogue in an elementary school has himself probably never traversed as a student the texts he is to teach, though his knowledge of the superior classics renders this superfluous, except in the point of appreciating the scholars' difficulties.

Owing to the ideographic nature of the language, one aspect of Chinese education is practically beyond the ken of western peoples. Each character requires a distinct memory effort, and the recognition of its form and name is made to come at one stage of instruction, its meaning much later on.

Dr. Smith compares the aggregate bulk of the classics which must be accurately engraved on the child's memory with the Old Testament. No other writings have been ground into the memories of so many of earth's millions; and the precepts they contain have had such a determining effect in producing Chinese character that, under the risk of being tiresome, we shall pause to glance at their content.

1. *The Trimetrical Classic*, a mosaic with three characters in each clause, universally employed unchanged for eight and a half centuries. Its 1,068 words, or 534 different characters, deal with the nature of man and of numbers, necessity and modes of education, filial and fraternal duties, the names of the heavenly bodies, the three great powers, four seasons, four directions, five ele-

ments, five cardinal virtues, six grains, six domestic animals, seven passions, eight kinds of music, nine degrees of kindred, and the ten moral and social duties, followed by a summary of future studies and a catalogue of dynasties up to 1644, when the present dynasty began, the latter not being thought a fit subject for instruction, as if a class in English history should halt at the accession of the House of Hanover!

2. *A Century of Surnames*, 454 clan names to be memorized.

3. *Millennary Classic*, 1,000 distinct characters, written A.D. 550 as a connected ode, possessing rhyme and rhythm, but no more poetry than the multiplication table; in fact, its characters are used as ordinals to designate the successive rows of stalls in the triennial examination halls. In subject matter it is similar to the 'Trimetrical Classic,' but more discursive.

4. The *Odes for Children*, 136 lines in rhymed pentameters, containing a brief description and praise of literary life and allusions to the changes of the seasons and the beauties of nature.

5. *Canons of Filial Duty*, a tract of 1,903 characters, representing a conversation between Confucius and a disciple concerning the chief virtue inculcated by his school.

6. *The Juvenile Instructor*, which is said to exhibit better than the works of later scholars the Chinese ideas in all ages on principles of education, rules of conduct, etc.

A host of commentaries (over fifty on 'The Juvenile Instructor' alone) more copious than the texts themselves are employed to illumine and amplify the string of ideas presented as 'primer-stimuli' to the youthful mind.

The task of memorizing the contents of these six *elementary* school books, which have had such a formative influence on the large proportion of students who go no further, is somewhat relieved by exercises in penmanship. After two or three years spent thus, explanations are in order, and the student is introduced to the various commentaries. Such a course of study surely stunts the genius and drills the faculties into a slavish adherence to venerated usage and dictation.

Though followed chiefly by those destined to practical lives, this curriculum far from fits them for ordinary duties. Formal letter-writing and even elementary arithmetic are not taught in the Chinese school of the old type, and proficiency in either is obtained only by a sort of apprenticeship or by private instruction. No knowledge of business Chinese is imparted, so that the majority of those who fail to carry their studies high enough for degrees are not prepared for practical life.

The course of instruction for those who are likely to try for literary honors consists of three stages, each of which embraces two leading subjects. The 'Trimetrical Classic' may have been taken as preparatory, though not necessarily.

I. In the first stage the aim is to get words at the tongue's end and characters at the pen's point, by memorizing the canonical classics and writing an infinitude of characters as a mere manual exercise—a system sure to prevent precocity and preclude originality. The whole of the 'Four Books' and often a good part of the 'Five Classics,' all in a dead language, are encompassed by pure memory before any ex-

planation of their meaning is given. 'The Four Books' require two years even for a clever scholar, while to include the 'Five Classics' extends the cheerless task to four or five years even for the cleverest, though a total of seven would perhaps strike the average. During this period of mental daze, the scholar is 'a pig in the woods'; his entrance on study is 'lifting the darkness,' and to teach a beginner is 'to instruct darkness.' Such phrases depict reality. The method of instruction and the characteristics of the teacher are the same as have already been noted.

The texts which are thus swallowed whole to await a deferred digestion are forever taken as models of correct composition and with their commentaries are regarded as embracing about all there is to know. 'The Four Books' contain digests of the moralizings of Confucius (551–478 B.C.) as gathered by his disciples, and consist of 'The Great Learning,' 'The Doctrine of the Mean,' 'Confucian Analects' and the 'Words of Mencius' (371–288 B.C.).

Confucius, the Aristotle of Asia, produced as a self-confessed 'transmitter and not a maker' a 'system of ethics or of anthropology' in which man, his relations to family, society, the state and heaven are fully discussed and the attributes and conduct of the 'Princely Man' elaborated in detail. The leading features of the Confucian doctrine are 'subordination to superiors and kind upright dealing with our fellow men.' The foundations of political morality are found in private rectitude. Though containing some exceptionable dogmas, these writings as compared with those of Grecian and Roman sages are good in their general tendency, and in adaptation to the life of the time eminently practical. The defects and errors of Confucianism are, briefly stated, 'the production of a character which is essentially mundane in spirit, the development of the passive rather than of the active virtues, the suppression of individuality, and the evil effects of neglecting the study of nature.'

The 'Great Learning,' *Ta Hsüeh* (or 'Learning for Adults,' 2,000 words), was, prior to Chü Hsi in the eleventh century, a section of the 'Book of Rites.' It discusses the duties and privileges of the princely or superior man, and has been styled a 'system of social perfectionating' or 'politico-ethical treatise.' Its authorship is unknown, but usually the first of its eleven chapters is attributed to Confucius, while the rest is due to the compilers, expanders and annotators through whose hands it has come. The portion supposed to have come directly from the master himself contains the following well-known climax:

> The ancients, desiring to manifest great virtue throughout the empire, began with good government in their own states. For this, it was necessary first to order aright their own families, which in turn was preceded by culti-

vation of their own selves, and that again by rectification of the heart, following upon sincerity of purpose which comes from extension of knowledge, this last being derived from due investigation of objective existences.

The *Chung Yung,* or 'Doctrine of the Mean' (or as Julien renders it 'L'Invariable Milieu,' or Williams, 'The Just Medium'), was also formerly a part of the 'Book of Rites,' and was compiled about 388 B.C. by K'ung Chi, the grandson of Confucius. Although in some respects the most elaborate treatise in the series (33 chapters), it is merely an enlargement upon certain general principles of the writer's grandfather concerning the motives and conduct of an ideal perfect man who 'without deflection or bias' pursues 'a course which never varies in direction.' Though in general rather monotonous there are some sprightly passages, for example, the following:

The princely man enters into no situation where he is not himself. If in a high position he holds no contempt for those below him; if in an inferior station, he uses no mean arts to curry favor with his superiors. He corrects himself and blames not others; never dissatisfied, he murmurs not at Heaven and feels no resentment toward man. Hence, the superior or princely man dwells at ease, entirely awaiting the will of Heaven.

Mankind is divided into three classes: (1) *shing,* or sages; (2) *hien,* or worthies; (3) *yu,* or worthless.

Men of the highest order, as sages, worthies, philanthropists, and heroes, are good without instruction; men of the middle class, such as farmers, physicians, astrologers, soldiers, etc., are good after instruction; while those of the lowest, as actors, pettifoggers, slaves, swindlers, etc., are bad in spite of instruction.

Sincerity is described as "the origin or consummation of all things; without it, there would be nothing. It is benevolence by which a man's self is perfected, and knowledge by which he perfects others." In another place we read 'one sincere wish would move heaven and earth.' The description which K'ung Chi has given of a true sage was probably intended to elevate the character of his grandfather to this height—a standard of excellence so high as to be unattainable by unaided human nature.

It is only the sage who possesses that clear discrimination and profound intelligence which fit him for a high station; who possesses that enlarged liberality and mild benignity which fit him to bear with others; who manifests that firmness and magnanimity that enable him to hold fast good principles; who is actuated by that benevolence, justice, propriety and knowledge which command reverence; and whose thorough acquaintance with polite learning and good principles qualifies him rightly to discriminate. Therefore his fame overflows the Middle Kingdom, and reaches the barbarians of north and south. Wherever ships and wagons can go, or the strength of man can penetrate; wherever there is heaven above and the earth beneath; wherever the sun and moon shine, or frosts and dews fall,—all who have blood and breath honor and love him. Wherefore it may be said that he is a perfect and holy man,—the peer of God.

The *Lun Yu,* or Analects of Confucius, is a record of the words and actions of the Sage compiled by the collective body of his first apostles

and abounding in sententious dialogues and monologues. It is to Confucius what Boswell's work is to Johnson. From it comes all we really know about the great moralist, contemporary with Ezra, whose mission was to teach duty towards one's fellowmen. The Analects are the pattern of Chinese wisdom literature.

The last of the 'Four Books,' bearing the name of Mencius (371–288 B.C.), is as large as the other three combined, and constitutes, according to some critics, the most vital reality in all Chinese literature. Its seven sections record the sayings and doings of a man to whose genius and devotion is due the triumph of Confucianism. Coming to maturity upward of a century after the death of Confucius, he studied under the latter's grandson, K'ung Chi, and though of course profiting greatly by the example and stimulus of the earlier sage, in most respects he displayed an originality, resoluteness and breadth superior to Confucius, and must be ranked as one of the greatest men Asia has produced. He served various native princes as minister in their several states and spent the last twenty years of his life in teaching and in completing the work which has been such a power in the land. Living at a time when feudal princes were squabbling over rival systems of federation and imperialism, he strove to inculcate the gentle virtues of the golden age. While his criterion was that of Confucius, his teachings were more practical and dealt rather with man's well-being from the view-point of political economy. His assertion of the respective duties and prerogatives of subject and ruler is said to be prior to that of any western writer, and in the Middle Kingdom has always been an incentive and guide in defending the rights of the people against the injustice of rulers, and an encourager to those who have governed justly. His dialogues with the great personages of his time abound with irony and ridicule against vice and oppression. Witness the following example, cited by Williams:

> The king of Wei, one of the turbulent princes of the time, complained to Mencius how ill he succeeded in making his people happy and his kingdom flourishing. "Prince," said the philosopher, "you love war; permit me to draw a comparison from thence; two armies face each other; the charge is sounded, the battle begins, one of the parties is conquered; half of its soldiers have fled a hundred paces, the other half has stopped at fifty. Will the latter have any right to mock at those who have fled further than themselves?"
>
> "No," said the king; "they have equally taken flight, and the same disgrace belongs to both."
>
> "Prince," says Mencius quickly, "cease then to boast of your efforts as greater than your neighbors'. You have all deserved the same reproach, and not one has a right to take credit more than another." Pursuing then his bitter interrogations, he asked, "Is there a difference, O king! between killing a man with a club or with a sword?" "No," said the prince. "Between him who kills with the sword, or destroys by an inhuman tyranny?" "No," again replied the prince.
>
> "Well," said Mencius, "your kitchens are burdened with food, your sheds are full of horses, while your subjects, with emaciated faces, are worn with misery, or die of hunger in the middle of the fields or in the deserts. What

is this but breeding animals to prey on them? And what is the difference between destroying them by the sword or by unfeeling conduct? If we detest those savage animals which mutually tear and devour each other, how much more should we abhor a prince who, instead of being a father to his people, does not hesitate to rear animals to destroy them. What kind of a father to his people is he who treats his children so unfeelingly, and has less care of them than of the wild beasts he provides for?"

The will of the people is always referred to as the supreme power of the state, and Mencius warns princes that they must both please and benefit their people, observing that "if the country is not subdued in heart there will be no such thing as governing it. . . . He who gains the hearts of the people secures the throne, and he who loses the people's hearts loses the throne. Good laws," he further remarks, "are not as effective as winning the people by good instruction."

II. After accurately memorizing the 'Four Books,' having relieved the drudgery with exercises in writing, the student generally enters on the second stage of his education, which, however, is unfortunately in many cases postponed until the 'Five Classics' have also been engraved on memory's tablet. In this second stage, the scholar is initiated into an understanding and translation into the vernacular of the sacred books previously committed. But the light is rather sparingly admitted even then. A simple character here and there is explained and perhaps after a year or two the teacher explains entire sentences. Judiciously employed, this does for the Chinese what translation into and out of the dead languages of the west does for us. Yet, as Dr. Martin claims, this second stage is made as much too easy as the first course is too difficult. Instead of requiring a lad, dictionary in hand, to quarry out the meaning of his author, the teacher reads the lesson, and demands simply a faithful reproduction; a feat of sheer memory again. Simultaneously with this training in exposition or translation the student begins to practise composition. But here again the lack of inflection and the predominence of collocation, the 'polarity' in which is determined by previous usage, make composition in the Chinese language difficult and throw the burden on the imitative faculty—a strong trait as evidenced at present among all classes of the people.

Although the whole course is designed with the civil service examinations in view, it is pursued without variation by those who are not looking toward office-holding. Yet at the close of this second stage, the boy who expects to enter civil service begins to prepare rather more specifically for the examinations. He is perhaps fourteen, and for two years or more he widens his reading, 'opens his pen,' and makes essays for his master's criticism, and may then be ready to enter the lists for the first degree.

III. In the third stage of the Chinese scholar's career, composition

becomes the main object, reading being wholly subordinate. According to Dr. Martin, the primary step in Chinese composition is yoking double characters followed by practise in reduplicating such binary compounds to form parallels, an idea which runs through the whole of Chinese literature. Detailed symmetry is a chief characteristic of Chinese composition as practised by old methods. Chiefly artificial forms of verse and an even more artificial form of prose are acquired and mark the climax of the whole course. The reading includes rhetorical models and sundry anthologies. History is studied, but only in compends, not to gain wisdom, but merely to embellish classic essays with a profusion of historical allusions. Knowledge and mental discipline are discounted and style is at a premium. In such a system progressive knowledge is alien and education with such a goal is necessarily superficial.

The 'Five Classics' follow the 'Four Books,' and we shall briefly note their content.

If not the oldest, certainly the most venerated member of this Pentateuch is the *I Ching,* or 'Book of Changes,' whose diagrams date back 2800 B.C., the text to 1150 B.C., and the Confucian commentary thereon to 500 B.C. It ranks chief in the canon of Taoism and was spared from the flames of the Tyrant of Ch'in to which all the other writings of Confucius and his disciples were consigned in 213 B.C., only to be rehabilitated from the living memories of devout literati. The accredited author of the text, Weng Wang, was the virtual founder of the great Chou dynasty (B.C. 1122–249) and the contemporary of Pythagoras. It is a fanciful system of philosophy based on a set of trigrams, each of which represents some power in nature whose combinations are developed in sixty-four short essays, enigmatically and symbolically expressed, on moral, social and political themes, as well as on the more lofty and subtile subject of the origin and destiny of cosmos. The whole universe, in broad and in detail, is ascribed to the interactions of two great male and female elements, the *Yin* and the *Yang,* which in turn proceed from *T'ai Chi,* or the first great cause. The text is followed by commentaries called the 'Ten Wings,' generally ascribed to Confucius, whose extravagant admiration of the *I* led him to declare that were a hundred years added to his life, he would give fifty of them to the study of the *I* so that he might come to be without faults. But the work appears to be little more than a lot of enigmatical gibberish intended for the prognostication of good and bad fortune. From it charlatans of all sorts have drawn their supplies. The following is a specimen of the text and the accompanying wing (Legge's translation):

TEXT. This suggests the idea of one treading on the tail of a tiger, which does not bite him. There will be progress and success.

1. The first line, undivided, shows its subject treading his accustomed path. If he goes forward, there will be no error.

2. The second line, undivided, shows its subject treading the path that is level and easy;—a quiet and solitary man, to whom, if he be firm and correct, there will be good fortune.

3. The third line, divided, shows a one-eyed man who thinks he can see; a lame man who thinks he can walk; one who treads on the tail of a tiger and is bitten. All this indicates ill-fortune. We have a mere bravo acting the part of a great ruler.

4. The fourth line, undivided, shows its subject treading on the tail of a tiger. He becomes full of apprehensive caution, and in the end there will be good fortune.

5. The fifth line, undivided, shows the resolute tread of its subject. Though he be firm and correct, there will be peril.

6. The sixth line, undivided, tells us to look at the whole course that is trodden, and examine the presage which that gives. If it be complete and without failure, there will be great good fortune.

WING. In this hexagram we have the symbol of weakness treading on that of strength.

The lower trigram indicates pleasure and satisfaction, and responds to the upper indicating strength. Hence it is said, 'He treads on the tail of a tiger which does not bite him; there will be progress and success.'

The fifth line is strong, in the center, and in its correct place. Its subject occupies the God-given position, and falls into no distress or failure;—his action will be brilliant.

The apparent meaninglessness thus exhibited is admitted by Chinese scholars, who, however, tenaciously believe that valuable lessons await those with the wit to understand them. Some fourteen hundred and fifty treatises on the *I*, embracing memoirs, digests, expositions, etc., are enumerated in the Imperial Catalogue, and the continued influence of such a work well illustrates the Chinese propensity for rules and methods along with their utter neglect of empirical research and the observational study of nature.

The *Shu Ching*, or 'Book of History,' goes further back in its records (2357–627 B.C.) than any of the other classics, though as a collected whole it seems to be due to the editorial effort of Confucius (551–478 B.C.). Only fifty-nine of the original hundred books are extant. They embody imperial ordinances and decrees, plans proposed by statesmen as guides for the sovereign, proclamations to the people, vows taken by the monarchs when engaging in battle, and mandates, announcements, speeches, etc., issued to the ministers of state. Much of the matter is presented in the form of dialogues between and about the kings and ministers of the various dynasties. These contain many of the best maxims of good government, both for rulers and ruled, which antiquity has bequeathed in any country. Many of the personages are legendary and some of their exploits fabulous. In the eyes of the Chinese who have not yet been affected by modern ideas, the *Shu Ching* contains the seeds of all things valuable. Williams says

it has at once been 'the foundation of their political system, their history, and their religious rites, the basis of their tactics, music and astronomy.'

The *Shih Ching,* or 'Book of Odes,' is another work which Confucius preserved for posterity. It is a collection of rhymed ballads whose ages run from probably 1719 B.C. to 585 B.C. They are 305 in number though they appear to have been reduced by mishaps and editorial selection from as many as 3,000. Giles thus exhibits their arrangement:

> (*a*) Ballads commonly sung by the people in the various feudal states and forwarded periodically by the nobles to their suzerain, the Son of Heaven. The ballads were then submitted to the Imperial Musicians, who were able to judge from the nature of such compositions what would be the manners and the customs prevailing in each state, and to advise the suzerain accordingly as to the good or evil administration of each of his vassal rulers.
>
> (*b*) Odes sung at ordinary entertainments given by the suzerain.
>
> (*c*) Odes sung on grand occasions when the feudal nobles were gathered together.
>
> (*d*) Panegyrics and sacrificial odes.

Confucius regarded a man unacquainted with the 'Book of Odes' as unfit for intercourse with intellectual men. According to him the design of all may be expressed in the one sentence, 'Have no depraved thoughts.'

Early commentators ignoring the natural beauties of these poems have saddled these ditties with weighty moral and political allegories. This may have served to preserve a work which would otherwise have been deemed too trivial. The native literature, illustrative, critical, and philological dealing with the 'Book of Odes' is not as large as that on the 'Book of Changes,' but Chinese scholars know it by heart, and each separate verse has been so searchingly examined that exegesis can go no further. The fifty-five commentaries mentioned by Legge in his translation increase our opinion of Chinese scholarship when we remember its isolation from the literature of other lands.

A nation's ballads have often been regarded as a more important factor in the life of the people than its laws, and the insight which the 'Book of Odes' gives into the customs and feelings of ancient China is its chief merit. While these poems lack the grandeur of the Greek and Latin productions, they are fortunately free from the looseness that too often detracts from the latter. As the 305 odes are usually committed to memory before coming to the examination hall, all poetical efforts of Chinese scholars have been practically molded by them.

Though in some of the odes women are roughly handled and perhaps the position of women to-day is in part due to their influence, the fairer side also appears, and contrasts in female character like those portrayed by King Solomon in the same age are presented. Witness

the following specimens, the first as translated by Giles and the second by Williams.

(1) A clever man builds a city,
A clever woman lays one low;
With all her qualifications, that clever woman
Is but an ill-omened bird.
A woman with a long tongue
Is a flight of steps leading to calamity;
For disorder does not come from heaven,
But is brought about by women.
Among those who can not be trained or taught
Are women and eunuchs.

(2) Maiden fair, so sweet, retiring,
At the tryst I wait for thee;
Still I pause in doubt, inquiring
Why thou triflest thus with me.

Ah! the maid so coy, so handsome,
Pledged she with a rosy reed;
Than the reed is she more winsome.
Love with beauty hard must plead!

In the meadows sought we flowers,
These she gave me—beauteous, rare:
Far above the gift there towers
The dear giver—lovelier, fair!

The eighth ode in Book III., called *Hiung Chi,* or 'Cock Pheasant,' contains a wife's lament on her husband's absence. Legge's version is:

Away the startled pheasant flies,
With lazy movement of his wings;
Borne was my heart's lord from my eyes—
What pain the separation brings!

The pheasant, though no more in view,
His cry below, above, forth sends.
Alas! my princely lord, 'tis you,—
Your absence, that my bosom rends.

At sun and moon I sit and gaze,
In converse with my troubled heart.
Far, far from me my husband stays!
When will he come to heal its smart?

Ye princely men, who with him mate,
Say, mark ye not his virtuous way?
His rule is, covet naught, none hate:
How can his steps from goodness stray?

The *Li Chi,* or 'Book of Rites,' is a collection (*cir* B.C. 135) of rules of personal conduct in private and public life, every movement in official or social life being controlled by it. There are two other similar works of considerably greater antiquity, but this one alone is included in the classic canon of examination texts. The Board of Rites, an imperial department, concerns itself largely in expounding and

enforcing the *Li Chi*. Its other principal duty is to manage the workings of the examination system.[2]

The fifth classic, *Chun Chiu*, or 'Spring and Autumn Annals,' is generally ascribed to Confucius himself, though not surely. It is a very brief record of the chief events between 722 and 484 B.C. in Lu, the native state of the sage. It seems to have been intended as a continuation of the 'Book of History,' but critics have shown that it is not only biased and unjust to the facts, but wilfully misleads. With it as it now exists there is associated the amplifying and vivifying commentary of Tso, a follower of Confucius, and without this, these annals, in spite of the fame of their reputed author, would not have merited and might not have received the attention that Chinese scholars have accorded them.

With these nine books the Chinese student saturates his mind in preparation for the examinations, and from them derives his training in sociology, ethics, political and other maxims, cosmogony, history, and historical romancing, poetry, and, by no means least, in manners. As Mr. R. E. Lewis has expressed it: "Though the curriculum is largely religious in its control, yet it provides practically no teaching of Theism. Though it is the permanent support of absolutism, yet it guarantees large liberties to the populace."

The classics which have been noted are by no means the whole of Chinese literature with which the aspirant for literary honors must be familiar. In order that his interpretation may be accurate as well as orthodox, he must consult some 1,120 commentaries on the 'Five Classics' and 170 on the 'Four Books.' For the scholar who has secured his first and second degrees there is the vast literature, over 3,000 volumes, of poetry, drama, romance and encyclopedic works covering with fluctuations in volume the stretch from 200 B.C. to the present time, though of course the later works are at a discount as compared with the more ancient. Professor Giles, of Cambridge University, has given an excellent review in his recent 'Chinese Literature,' as has also Dr. Martin in his 'Lore of Cathay.'

[2] Both the examination system and the Board of Rites were abolished by imperial edicts of September and October, 1905.

THE GEOLOGIC SURVEY OF ALASKA[1]

By ALFRED H. BROOKS
U. S. GEOLOGICAL SURVEY

A DECADE[2] ago the United States Geological Survey began its work in Alaska by sending a party of only three men to the territory, whereas in the past summer twelve parties, with an aggregate membership of fifty odd men, were there engaged in geologic surveys. Even this rapid expansion is hardly commensurate with the size of the territory and the importance of the mineral resources, the development of which the geologic investigations aim to aid. Alaska's 600,000 square miles are much spread out, stretching to a width of 2,400[3] miles and to a north and south length of 1,100 miles. Were this vast area, which is equal to two and a half times that of Texas, the cold, barren waste so often pictured it would be of small practical import as to when it should be surveyed. But Alaska has large and constantly growing mining interests, and it is the demand of these which has influenced congress to increase the appropriation for geologic surveys from $5,000 in 1895 to $80,000 in 1905.

Even the present appropriation is less than one per cent. of the annual gold production, which has increased from $1,866,645 in 1895 to $9,300,000 in 1904, and is far from having reached its maximum. Nor does the gold production tell the whole story; the value of the copper and silver annually mined now exceeds half a million dollars, and the output of the former is rapidly increasing. There is in Alaska also some coal mining, though this industry has not yet attained its rightful importance. The territory contains some very valuable bituminous coal fields. Prospective mineral wealth also lies in Alaska's tin ores, oil fields and gypsum beds, which have all been sufficiently exploited to indicate their probable commercial importance. The time will come when iron and zinc ores are mined in Alaska, and its immense granite areas will yield building stone to the Pacific coast.

Applied geology touches the activities of mankind at many places, but primarily, of course, in the vocation of mining. It is on the basis of geologic knowledge that soils must be classified, and this, in turn, together with the topography, determines the distribution of animal and vegetable life. In the Alaskan work of the geological survey,

[1] Published by permission of the Director U. S. Geological Survey.

[2] It will be shown below that members of the Geological Survey were sent to Alaska before 1895, but these were either detailed to other government bureaus, or were attached to private expeditions.

[3] This is about the distance from Savannah to Los Angeles.

practically only the needs of the miner have to be considered. The agricultural and allied interests of the territory are being investigated by other governmental bureaus.

The attitude of the public towards the science of applied geology has so materially changed during the last decade that its practical value is now generally recognized, though a few still remain skeptical as to the commercial importance of the results. This attitude exists partly because geology (not being an exact science) has often been brought into disrepute by dilettantism, if not downright charlatanism. Among technicians, however, it has become generally accepted that with the increase of geologic knowledge of a given region comes a decrease of the element of chance in the discovery of ore bodies. Intelligent prospecting should and can be based upon scientific principles, for a properly executed geologic map will define the areas within which there is a probability of finding a given kind of mineral deposit. The veriest tyro need hardly be told not to seek coal in a granite, nor would he ordinarily prospect for gold in a region of coal-bearing rocks. The geologist carries this classification of the rocks still farther, and may thereby prophesy the occurrence of ore deposits in a region which he has mapped. The actual discovery of ore is no part of the work of the geologist; this demands detailed examinations and often excavation, such as only individual property-owners can make. This point is emphasized because, even among the well-informed, the question is often raised why the geologist does not more often discover mineral deposits. Lack of appreciation of the relation of applied geology to mining is traceable in part to the stories current of the bonanzas discovered by an accident to a mule, the luck of a tenderfoot or the appetite of birds, which are in the popular mind so interpreted as to throw discredit upon geologic science.

The intelligent prospector has learned that even at best his chance of success is small; but is much increased by a knowledge of the geology of a region he intends to explore. With a better understanding of the laws which govern the occurrence, origin and distribution of mineral deposits the old-fashioned, picturesque haphazard prospector, to whom it must be admitted we owe the discovery of most of our mineral wealth, will disappear, and the technician will take his place. This is probably the last field where the specialist will crowd out the man of purely practical training; but it is a substitution bound to take place in time.

A geologic survey has two objects: first, the increase of scientific knowledge, and, second, the application of this knowledge to the mining industry. The purely scientific investigations include many subdivisions and ramifications that can not here be considered, but it will be evident, even to the layman, that, while any part of the earth's surface

remains geologically unmapped, there will be a hiatus in our knowledge, which may prevent broad generalizations.

In Alaska special attention has been given to the second field of activity, namely, the application of geology to the needs of the miner. This is in part the influence of the growth of economic work in both state and federal surveys during the last decade, but more specially because the appropriation is specifically made for the investigation of the mineral resources of Alaska. With this end in view, a score of publications dealing with the occurrence and distribution of the mineral deposits of the territory have been issued. It has been the policy to make public the results attained while yet the investigation is in progress, in the belief that even an incomplete knowledge of the geology would be of value to the miner. With this end in view, bulletins treating of the occurrence of coal, petroleum, tin and copper have been issued, as well as many which are devoted to the gold deposits. These preliminary reports have found favor with the mining public because of their timely appearance, and have forestalled criticism of delay in issuing the more elaborate treatises.

The danger in issuing such reports is that the less intelligent miner may accept tentative statements as final conclusions, and this may lead to losses. It is impossible to escape this danger entirely, for to avoid all opinions which are not definitely established by the facts in hand, shears a geologic report of much of its usefulness to the practical man, who wants the expert who has visited the field to prophesy what the conditions of occurrence of the ore bodies are likely to be.

While applied geology has been kept constantly to the front in the Alaskan investigations, the study of the broader problems, be they stratigraphic, physiographic or paleontologic, has by no means been lost sight of. The purpose of every geologist sent to the north has been twofold: first, the gathering of information which will directly advance the mining interests, and, secondly, the study of the purely geologic problems. It has been the policy to defer the publication of purely scientific results until a larger number of facts have been accumulated, and the theoretic discussion can be supported by the knowledge of a wider field. Thus only the salient outline of the stratigraphic succession has been put in print, but meanwhile a number of specialists have been carrying on paleontologic and stratigraphic studies to determine definitely certain geologic horizons to which all future work can be referred. In the same way, though a large petrographic collection has been amassed, its detailed study has been deferred until a broader knowledge of the field relations can be secured. Other branches of geologic science have been treated in a similar way. It is hoped that in this way a basal knowledge of the larger problems will be available in a few years, on which to found detailed studies with more assurance.

A geologic map can not be constructed without an adequate base map. As in the west there were practically no adequate and systematic topographic surveys of the interior before the organization of state and federal geologic bureaus, it naturally fell to these organizations to construct base maps for their work. The same holds true of Alaska, where the conditions have been even less favorable because of the many large areas which have been practically unexplored. It is no exaggeration to state that, at the inception of this work, there was not a single area, large or small, except at the actual coast line, of which there was a map of even approximate accuracy. A few explorations had, to be sure, been made; but the resulting maps were absolutely worthless for geologic mapping and of little use for anything else. Thus the survey of one of the largest rivers of the territory proved to be thirty to forty miles out in location, near-by mountains, whose altitude had been indicated at seventeen to nineteen thousand feet, proved to be less than fifteen thousand feet in altitude. It is evident, then, that an investigation of the mineral wealth had to be preceded or accompanied by accurate geographic surveys. Maps were needed not only by the geologist, but also by the prospector and miner. The mining interests demanded that watercourses should be surveyed and passes and watersheds explored. During the Klondike excitement of 1898 there were at least 10,000 people in Alaska who were attempting to follow unexplored routes and to navigate unmapped rivers. It is no exaggeration to state that the cost of these fruitless efforts aggregated several million dollars, many times the cost of a survey of the entire territory. In view of these conditions, much of the money, therefore, appropriated for the investigation of Alaska's mineral wealth was necessarily used for explorations and for topographic surveys.

Older Explorations and Surveys.

It will be well to review briefly the progress of Alaskan explorations previous to the time when the Geological Survey entered this field. When, in 1867, Russia ceded all her North American possessions to the United States, so little was known of this province that it is hard to understand what was the basis for the purchase price of $7,200,000. To Russia Alaska had been a field for private speculation rather than an integral part of the empire. First, ravaged by the itinerant and half savage fur trader, and then, for two thirds of a century, in the complete control of an incorporated company, the territory was probably not regarded as a valuable asset by the Czar and his advisers. To be sure, during the last two decades of the Russian dominion, naval officers had been been sent from St. Petersburg to govern the colony, and a semblance of imperial authority was thereby kept up; but this control was limited to but a fraction of the coast line and to the lower

courses of some of the larger rivers. The Russian posts were all stockaded, and the powers of the governor were practically limited to the range of his crude artillery. The Russians made some coastal surveys, a few inland explorations, and one abortive attempt to find gold, and this was as far as they went in the study of the resources of their distant colony.

William H. Dall and his associates of the Western Union Telegraph expeditions, in 1865–7, did much toward gaining a knowledge of the vast interior. The navigators of various nationalities, who had explored and charted the coast line, had gathered fragmentary data of the natural history and geology, and these, together with the specimens collected by them, had found their way to European museums, where they were examined and described by scientists. One of these, by name Carl Greywingk, a German, with infinite pains and thoroughness, compiled all the notes on the geology and geography of Alaska, then known as Russian America. He went so far as to publish a geologic map of a part of the territory—a very remarkable piece of work, considering the fragmentary character of his data.

It appears that the people of the United States were even more indifferent to Alaska than the government at St. Petersburg. There had been strong opposition to its acquisition, both by those adverse to any territorial expansion, and also by a much larger number, who believed that we were purchasing a barren waste of ice and snow, whose only resource was furs. After the treaty had been signed and military occupation had been taken, the general opinion seemed to be, even among the annexationists, that we had fulfilled our duties toward the new possession. A policy of neglect of this northern province has been consistently followed almost to the present day. It was sixteen years after its annexation that Alaska was given a civil government, it was thirty-three years before it was given a complete civil code, and over a quarter of a century elapsed before systematic steps were taken toward investigating its resources.

In the meantime, individual enterprise did much toward opening the province to civilization. A strong corporation had succeeded to the interests of the old Russian American Fur Company, and, though it inherited most of the prejudices of its predecessors against the introduction of any new enterprises, nevertheless its agents, bent only on the acquisition of furs, did not a little to find new fields for the prospector.

The real exploration began with the advent of the restless gold seeker. The search for gold on the west coast of our continent, begun by the discovery of the California placers in 1848, gradually moved northward into British Columbia, and by 1870 had reached the Cassiar district, close to the Yukon watershed. It was the men trained in

the placer fields of British Columbia who first prospected in Alaska, and who by 1880 were mining in the Juneau region, and a few years later in the Yukon basin itself. These facts are here set forth because it was the prospector who made almost the first observations on the geology of the interior.

There were, to be sure, a number of exploring expeditions which, considering the resources at their command, had achieved important results, but they were geographic rather than geologic. Thus Frederick Schwatka, U.S.A., following the route blazed out by early prospectors, crossed the Chilkoot Pass in 1883 and made his way down stream to the mouth of the Yukon. In 1885 H. T. Allen, U.S.A., explored the Copper, Tanana and Koyukuk rivers, while about the same time G. M. Stoney, U.S.N., and J. C. Cantwell, U.S.R.C.S., led expeditions which penetrated the Arctic watershed of Alaska. The Canadian geologists, George M. Dawson and R. G. McConnell, had meanwhile explored the Canadian part of the Yukon basin. In 1890 I. C. Russell, of the Geological Survey, reconnoitered the geology of the Yukon, while attached to a coast survey party whose aim was to determine the position of the international boundary. Schwatka made a second trip into the interior in 1891 and this time was fortunately accompanied by C. W. Hayes of the U. S. Geological Survey, who made important additions to both geographic and geologic knowledge. Since the acquisition of the territory, the coast survey has been steadily at work charting the shore line, and much was learned of the geology of the littoral province by Wm. H. Dall, long attached to that organization. John Muir's fascinating accounts of the glaciers of Alaska attracted widespread attention, and a number of expeditions were sent north to study them.

By all these means considerable geologic data were accumulated, though actual surveys were entirely lacking. A few official publications made reference to the mineral deposits, but these statements were unreliable because based purely on compiled information, and were taken at their true value by the public, which paid small heed to reports of valuable ore bodies in this northern field.

Systematic Surveys.

As year after year placer gold continued to be brought from the Yukon region and mining along the coast continued to expand, there arose a demand for more exact information. This led to a small appropriation which enabled the United States Geological Survey to send G. F. Becker and Wm H. Dall north to study the coal and gold deposits along the Pacific coast in 1895, while the following year J. E. Spurr, with two others, visited the gold placers of the Yukon. These two expeditions represent practically the beginnings of geologic surveying in this province.

Public attention was focused on Alaska by the discovery of the rich placers of the Klondike in 1896. Though these deposits lay in the Canadian-Yukon, it was close to the boundary, and the public generally regarded all of Alaska as lying within the gold field. Congress in 1898 increased the appropriation for Alaskan surveys and has since that time been liberal in supplying funds for this purpose.

There was an urgent demand for immediate information about routes, conditions of travel and occurrence of mineral wealth, on the part of the thousands who had started, or were about to start, north. Plans had to be formulated and parties organized in great haste, for the money did not become available until about the end of February. The task which confronted the Geological Survey was far from being easy. But little was known of this vast region which stretched toward the pole, much of which was locked in the ice over half the year. The field of operations could be reached only by long journeys by sea and land, and there was little in the way of experience to base the plans upon. Thanks to Spurr's journey into the Yukon, something was known of the conditions of travel, and the first season's plans were largely formulated by him. It appeared that the most important work was to make explorations to determine the geographic features and, as far as possible, to establish the distribution of the placer gold. Detailed surveys were out of the question; with the funds available they could not be made rapidly enough to meet the public demand. Moreover, so little was known of the region, that it was impossible to make choice as to which were the more important districts. It was, therefore, necessary to precede areal surveys by a system of explorations. Such had been the procedure in the western part of the United States during the preceding half century. The explorer was the first in the field, and it was only after the unknown regions had been honeycombed by many explorations that areal surveys were undertaken.

The routes leading inland from the coast appeared of first importance, and hence received the first attention. A bold mountain barrier stretches along the entire shore line of Alaska, as far west as Cook Inlet, and, previous to 1898, inland travel had crossed the barrier only at Chilkoot Pass, which leads to the Yukon through northern British Columbia. To the west two large rivers, the Alsek and the Copper, empty into the Pacific. Both had been traversed by white men and reported as unnavigable. Of a third, the Sushitna River, emptying into Cook Inlet, little was known. The problem was to seek a feasible route which should avoid traversing Canadian territory, and an important part of the first year's plan was explorations looking to this end.

In cooperation with the War Department, one geologist explored inland from Prince William Sound, while another mapped a route from the head of Cook Inlet. A Geological Survey party carried on

an exploratory survey up the Sushitna River and discovered a low pass into the Yukon basin. The Alaskan Range, which lies west of Cook Inlet, was traversed by another party, which found a broad pass into the Kuskokwim, which it descended, and, making a broad circuit, reached the Pacific coast again after traversing the Alaskan Peninsula. Two parties crossed to White Pass, then being used by thousands of gold seekers, and descended the Lewes and Yukon rivers in canoes. One of these ascended the White River, portaged to the Tanana, and continued down that stream to the Yukon. The other surveyed an area of about 2,000 square miles adjacent to the International Boundary and lying close to the Klondike gold fields.

The personnel of the four expeditions last mentioned included a geologist and a topographer, the senior of the two being in command. These officers were selected from the staff of the survey, among those who had had from five to twenty years of training and who were believed to have special aptness for exploratory work. From four to six canoeists, cooks, etc., completed each party, and these were picked among those who had rendered faithful services to the Geological Survey in other fields. It was important that they should be such men as could be relied upon in emergency, and particularly such as would not desert the party during a gold excitement.

As most of the surveys were to be along rivers, canoes were determined upon as means of transportation, and careful consideration led to the choice of those of the voyageur type, built in Canada. These boats, which were propelled with paddles and poles, combined the quality of staunchness with lightness and durability. A canoe from eighteen to nineteen feet long, weighing about one hundred and twenty-five pounds, was provided for every two men. It would carry a load of half a ton, and could be transported across a portage by its crew. The camp equipment, of the simplest character, included a sleeping bag for each man, a small mosquito-proof tent for every two men, a light cooking outfit, axes and a few tools. Not the least important part of the equipment was the repairing outfit, including some strips of cedar which were carried in each canoe, for the boats were so light that it was impossible to escape occasional injuries when running rapids. A light carbine with a hundred rounds of ammunition was carried in each canoe. The topographer was provided with a light theodolite and plane-table, while the geologist carried only a few hand instruments and cameras. Each member of the party was obliged to limit his personal baggage to the barest necessities; but was provided with mosquito-proof head-dress and gloves. The equipment of six men, aside from eatables, on a journey of four to five months, did not exceed 400 pounds in weight.

For the first season's work the provisions were limited to a very

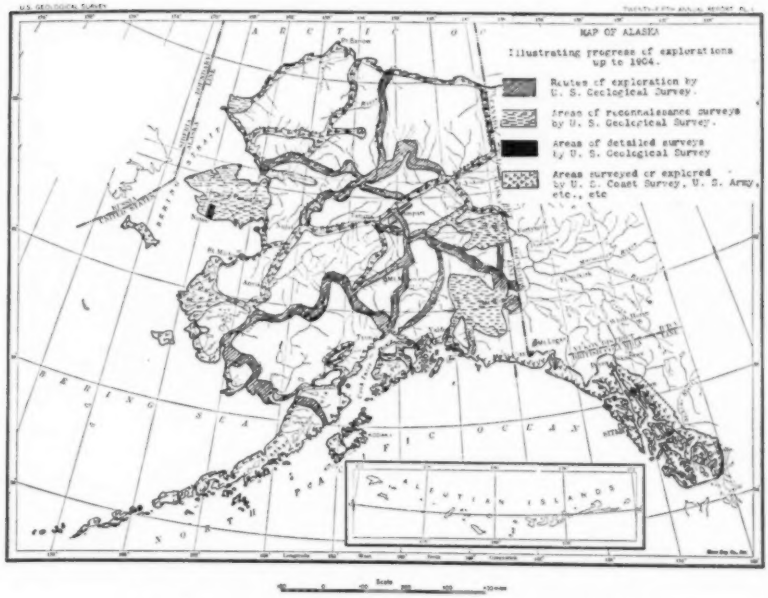
simple ration, consisting of little more than bacon, beans, flour and coffee, with a little butter, sugar, dried fruit and some farinaceous foods. The simplicity of the rations made it possible to reduce its weight to less than three pounds per man a day. Experience has shown, however, that there is economy in carrying more variety of food, as it keeps the party in better health and spirits. All perishable supplies were double-sacked and made absolutely water-proof. The wisdom of this precaution was many times made evident when the canoes were overturned or injured.

The methods of travel were practically the same for all the parties.

1. MAP OF ALASKA, ILLUSTRATING PROGRESS OF EXPLORATION UP TO 1904.

Up-stream journeys were made by dragging the canoes with ropes, called 'tracking,' by which from two to ten miles a day could be accomplished, depending on the swiftness of the current and the character of the banks. If conditions were favorable, recourse was had to poling, by which much better time can be made. When the head of canoe navigation was reached, explorations into another watershed were made and a portage route determined upon. Then, if necessary, a trail was chopped and bridges built. Finally, the whole outfit was carried over by the members of the party. The longest portage made by a survey party was eighteen miles; but the work of transporting half a ton of supplies for such a distance is almost heart-breaking.

The methods of survey were determined more or less by the means and rapidity of travel. In most cases it was possible to make a fairly


MAP OF ALASKA
Illustrating progress of explorations up to 1904.
Routes of exploration by U. S. Geological Survey.
Areas of reconnaissance surveys by U. S. Geological Survey.
Areas of detailed surveys by U. S. Geological Survey
Areas surveyed or explored by U. S. Coast Survey, U. S. Army, etc., etc
ARCTIC O
BERING SEA
PACIFIC OCEAN
ALEUTIAN ISLANDS

2*A*. Map of Alaska, showing unexplored areas in 1895.

accurate reconnaissance map, with elevations indicated by contours; but where time pressed, a canoe traverse, with estimated distances, was substituted. Fortunately it proved possible to carry a rough triangulation, checked by latitude and azimuth observations, throughout much of the explored regions. The topography was sketched, on a field scale of about three miles to the inch, with the aid of a plane-table. Altitudes were determined as far as possible by vertical angles, but in many instances depended solely on the readings of aneroid barometers. Contours were sketched at intervals of 200 feet, or, if the topography was very rugged, 500 feet. In some cases it was possible to run stadia lines along the rivers, and salient topographic points were located by intersections. Though some of the journeys were accomplished under exceeding difficulties, in no instance were the surveys entirely interrupted.

The movements of the party were guided more by the requirements of the topographic than of the geologic surveys, and the geologist was perforce required to get such information as he could. Continuous series of notes were kept and specimens were assiduously collected. Special attention was given to the occurrence of placer gold and other metalliferous deposits, but all phases of geologic problems were studied as far as circumstances would permit. Probably the most important scientific results were those that had to do with the general physiographic problems. In most cases only the broader features of the stratigraphic succession could be determined, but even these results,

bearing as they did on the geology of an important part of the American continent, proved of value. The work that has since been done has shown that it is in Alaska that we must seek the meeting-point of the stratigraphy of the old world and the new.

The methods and plans for the first season's work have been presented in some detail, as they afford an insight into the difficulties encountered and the character of the work. During the following winter the more important economic results were thrown into popular form for immediate publication. It is no exaggeration to state that, had it been possible to give to the public a year earlier the information obtained during this first season, *i. e.*, before the Klondike rush began, hundreds of thousands of dollars might have been saved: first, by directing the inland travel along the best routes, and, second, by furnishing a clew to the general distribution of the placer gold.

Thanks to the increased knowledge of the conditions of travel, and of the general geography, it was possible to direct the second season's work much more intelligently. It was discovered that horses could be used, which gave the parties far more mobility. During this season the explorations of the Yukon basin continued, and an examination of the newly discovered Nome placers was made. The latter, then thought to be a mere incident in what was considered more important work, proved to be of first interest to the public. A brief account of this gold field was published and placed in the hands of a large percentage of the thousands who started for Nome in the spring of 1900.

2*B*. MAP OF ALASKA, SHOWING UNEXPLORED AREAS IN 1905.

At the opening of the third year, explorations had been carried over so large an area that it seemed wise to defer their continuance until some areal surveys could be executed. These were so vigorously pushed that at the end of the summer nearly 15,000 square miles had been mapped. Since that time the areal work, both geologic and topographic, has held first place, though explorations have not been entirely neglected. The most notable of the explorations was made in 1902, when a small party, under the leadership of W. J. Peters and F. C. Schrader, starting in the dead of winter, made a 1,400-mile journey with dog teams. When the ice broke they continued their explorations in canoes, reached the arctic divide, portaged across and descended the Colville River to the Polar Sea. There they skirted the coast westward, rounded Point Barrow, the northernmost cape of Alaska, and finally reached Nome.

Results.

A comparison of the two maps here reproduced will indicate the progress of the areal surveys, and this matter is summarized in greater detail in the following table.

	Sq. Miles.
Explorations by U. S. Geological Survey	80,000
Geologic and topographic reconnaissance surveys	60,000
Explorations by other departments	50,000
Coastal province, shore line surveyed by coast survey and some geological surveys made by geological survey	120,000
Unmapped and practically unexplored	310,000
Total area of Alaska	620,000 ±

Besides this about one thousand square miles have been surveyed in great detail. The above statement does not include the extensive special investigations of mineral resources which have been made, for which about twenty per cent. of the total appropriations has been used.

It is difficult now to realize how little was known of Alaska previous to 1896. The general courses of the larger drainage features were laid down on maps, but only in a very crude way. The coastal mountains were known, but the two great inland ranges, one of which contains the highest peaks on the continent, were hardly indicated on any map. Only a few of the passes were known and the altitude of not a single point away from the coast had been established. Now all but two of the larger rivers have been surveyed, and contour maps have been made of over 150,000 square miles. All of the larger geographic features have been outlined by the network of explorations which have been extended over the entire territory. There are no new mountain ranges to be discovered, though there are several which are but imperfectly known.

In the purely geologic work the results are still more striking.

While a decade ago only a few facts about the geology of the coast province was known, it has been possible now to prepare a preliminary map of the geologic features of over half the territory. The stratigraphic studies are of still greater interest, for they have shown the presence of many horizons in northwestern America that were previously unsuspected.

The economic results have been touched upon in the previous pages. The proof of their comprehensiveness lies in the fact that there is not a single mining district in Alaska which has not been reported upon. An inquiry in regard to the mineral resources of any part of Alaska, coming to the office of the survey, is now met with a printed report containing the latest and most authentic information.

While much has been accomplished, much remains to be done. Over half the territory has not been covered by even reconnaissance maps. Even these will not suffice in regions of important mineral production, where often hundreds of thousands of dollars are being invested, and detailed surveys, comparable to those made in the states, are demanded. Railways are in construction, involving expenditures of millions of dollars, and, though these are being built without any direct governmental aid, such as is being extended in the Philippines, the capitalists who are financing them have a right to expect that the government will at least explore routes and furnish reliable information regarding the resources of the region to be traversed. It was this liberal policy which hurried the construction of the transcontinental lines a generation ago. There are parts of the territory which have considerable prospective agricultural value, and their settlement will be hastened, if their topography and resources are made known. Roads must be constructed, and this can only be properly done on the basis of a full knowledge of the geology and topography.

In its relation to the federal government, Alaska differs from any other possession of the United States. Though heavily taxed, the 30,000 white residents have no voice in the making of their laws. Porto Ricans and Hawaiians have territorial government, the Filipinos have their commission, but Alaska must depend entirely on the benevolent paternalism of a legislative body 5,000 miles away. In this northland there are thousands who have been struggling with adverse conditions to open up a new land, who have thereby benefited the whole country. These people have a right to expect that the people of the United States will come to their aid in the development of Alaska.

WHAT IS AN EAR OF CORN?

By E. G. MONTGOMERY
THE UNIVERSITY OF NEBRASKA

IT is generally thought that corn (*Zea mays*) originated from some plant like teosinte (*Euchlæna*), and that the ear is the result of the fusing together of a number of two-rowed pistillate spikelets, such as are found in *Euchlæna*. Hackel[1] evidently holds this view, for he describes the pistillate flowers of corn as being similar to those of *Euchlæna* and borne on spikes, except that "the pistillate spikes (originally by monstrous or teratological development?) are grown together into a spongy continuous club-shaped body (the 'cob') upon which the four to eleven double rows (each sessile upon a low longitudinal

FIG. 1. PHOTOGRAPH SHOWING STEPS OF EVOLUTION OF THE CORN TASSEL INTO AN EAR.

elevation, that is limited by a long, shallow furrow on each side) correspond to a single spike of *Euchlæna.*" This view is also accepted by Harshberger,[2] who made a careful study of the corn plant, and I believe is the theory generally accepted as to the origin of the corn ear.

[1] Hackel, 'The True Grasses' (trans. by Scribner and Southworth), page 38.

[2] Maize, 'Contributions from the Botanical Laboratories of the University of Pennsylvania, pp. 75–202, 1893.

I have often noted abnormal developments or possible reversions which have suggested to me another explanation. These offer much evidence that instead of the ear originating from the fusion of a number of two-rowed spikes, it developed directly from the central spike of some tassel-like structure similar to the well-known corn tassel. Tassels may be found where only a few pistillate flowers have been formed on the central spike and others with more and more such

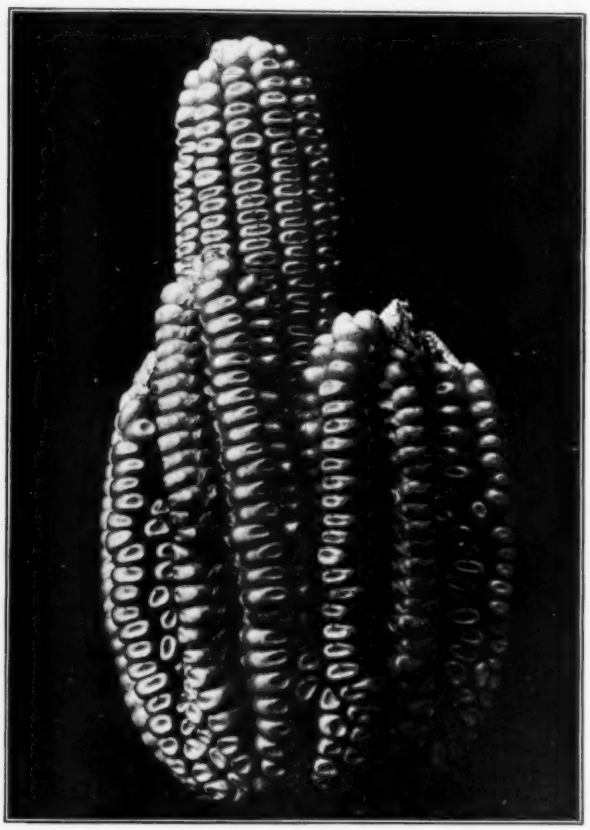


FIG 2. A CASE IN WHICH WE HAVE A WELL DEVELOPED TWELVE-ROWED EAR corresponding to the central spike of a tassel and surrounded at the base by a number of four-rowed 'nubbins' that correspond to the lateral branches.

flowers, up to where a fair-sized ear has been developed. The accompanying photograph (Fig. 1) shows some of the steps from a normal tassel up to a perfect ear. Note that in the first step the plant is almost normal (at the left), in the second the central spike of the tassel is fairly well developed into a small ear, the number of lateral branches has been somewhat reduced, and the internode below the tassel is somewhat shortened, so that the base of the tassel is partly enclosed. In the third step all the lateral branches have disappeared but two, and the

ear-like structure is almost enclosed in the leaf sheaths; in the fourth step only the well developed central spike remains, and is entirely enclosed in the leaf sheaths, owing to the shortening of the internodes

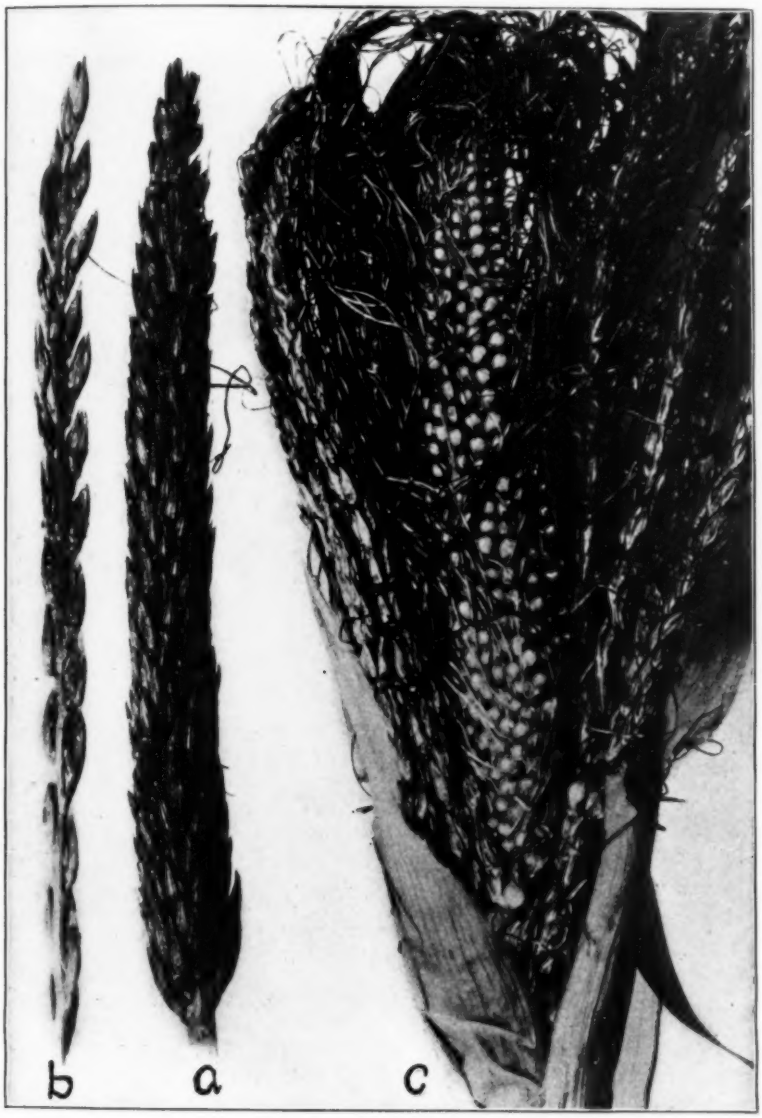


FIG. 3. *a*, Central spike of tassel bearing pairs of spikelets in eleven rows; *b*, lateral branch of tassel bearing pairs of spikelets in two rows; *c*, tassel in which central spike is developed into an ear.

below. The last step illustrates a well developed ear, also showing the much shortened internodes below, and the very greatly reduced leaves, which in the highest types of corn completely disappear, leaving only

the leaf sheaths enclosing the ear. It is just as possible for the lateral branches to develop pistillate flowers as for the central spike, and they often do so. The accompanying photograph (Fig. 2) exhibits a case in which we have the central spike and also the lateral branches developing pistillate flowers. But ordinarily in evolution when one portion begins to develop it is at the expense of other adjacent parts. In such case, the development of the central spike of the tassel is accompanied by the disappearance of the lateral branches. By removing the surrounding 'nubbins,' we find that there is a normal ear in the center.

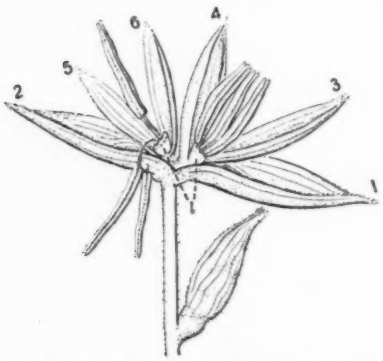


FIG. 4. STAMINATE FLOWER OF CORN (*Zea mays*). 1, First empty glume; 2, second empty glume; 3, first flowering glume; 4, first palet; 5, second flowering glume; 6, second palet; 7, lodicules. The upper flower matures first, but the palet and glume are smaller than in the lower flower.

The central spike of the normal tassel usually has from four to eleven rows of spikelets in pairs, making eight to twenty-two rows of corn when developed, while the lateral branches usually have only two rows of spikelets in pairs, making only four rows of grain when well developed.

It is interesting to note the morphological changes which take place in the modification of the staminate flower into the pistillate. The staminate spikelets are borne in pairs (sometimes in threes), one sessile, the other pedicellate, the pairs alternating. As already stated, the pairs of spikelets are borne in two rows on the lateral branches, and in four to eleven rows on the central spike of the tassel (Fig. 3). The structure of the staminate spikelet is shown in Fig. 4. The outer glumes enclose two sessile flowers, and are 7–12-nerved; flowering glumes are 3–5-nerved, the palet 2-keeled, lodicules 2, fleshy and truncate. There is usually more or less difference between the upper and lower flowers in a spikelet; the upper flower matures first, and the palet is larger than the glume, while in the lower flower the glume is larger than the palet (Fig. 4).

The first tendency toward the development of a pistillate flower is indicated by a shortening of the pedicellate spikelet until it becomes

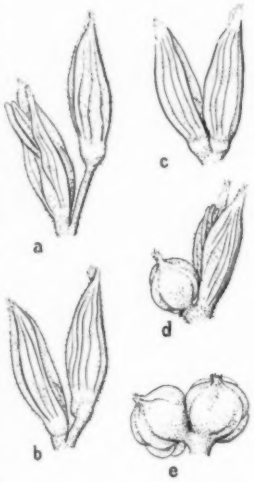


FIG. 5. MODIFICATION OF A PAIR OF STAMINATE SPIKELETS INTO A PAIR OF PISTILLATE SPIKELETS, *a*, *b*, *c*. The pedicellate spikelet shortens down until it becomes sessile. *d*, The sessile flowers become pistillate; *e*, both flowers become pistillate.

sessile (Fig. 5, *c*). This is accompanied by an increased difference between the flowers, as mentioned above. As modification progresses, the lower outer glume shortens and becomes thicker and more corneous. The palet and glume of the upper flower show a tendency to become

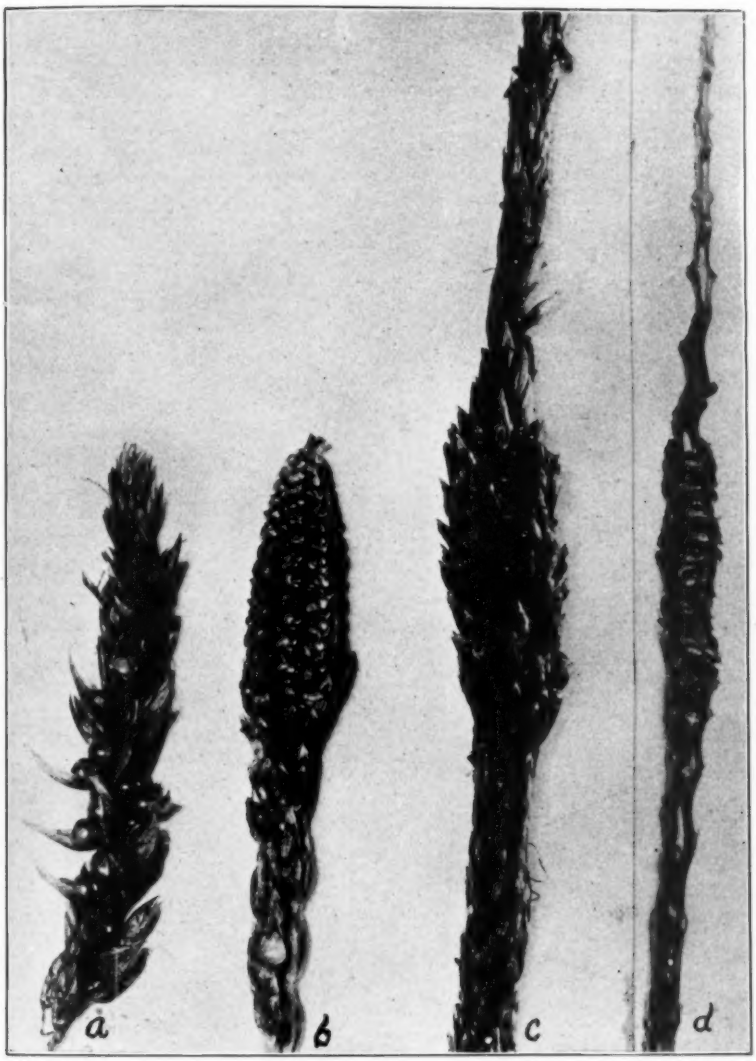


FIG. 6. SPECIMENS FROM CORN TASSELS; *a*, Branch of pod-corn tassel showing twinned grains; *b*, Central spike of tassel with tip developed into small ear; *c*, central spike of tassel developing pistillate flowers near middle; *d*, same as *c* with flowers removed to show tendency of central rachis to develop into a cob-like structure where pistillate flowers are borne.

more reduced, while the lower flower becomes practically abortive, except that the palet and glume are still of normal size. In the first stage after the flower has become pistillate (Fig. 5, *d* and *e*), the two

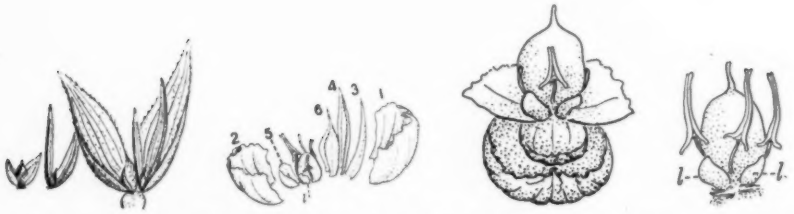


FIG. 7. VERY YOUNG PISTILLATE FLOWER FROM TASSEL OF POD CORN. Note difference between size of pistils and size and form of glumes and palets. The lower flower would probably be abortive.

FIG. 8. HERMAPHRODITE FLOWER. The parts are all numbered to correspond with Fig. 5.

FIG. 9. HERMAPHRODITE FLOWER OF MAIZE (*Zea mays*). The anterior stamen is fairly well-developed, while the other two are mere remnants.

FIG. 10. HERMAPHRODITE FLOWER OF MAIZE (*Zea mays*).

outer glumes are found to be greatly thickened and somewhat corneous. The palet almost encloses the young ovary, the glume covering only a narrow space on the back (Fig. 8), and the tip of the ovary often protruding. The palet and glume of the lower flower (which is now entirely abortive) are more or less hyaline and closely pressed against the dorsal side of the grain. However, in all varieties of corn both flowers in a spikelet will sometimes be found well developed. Twinned grains are especially common in the tassels of pod corn (*Zea tunicata*) (Figs. 6 and 7). Sturtevant[3] mentions an ear of podded flint corn from Ohio in which the kernels were twinned in the pod.

Hermaphrodite flowers are sometimes found; in fact, in tassels where pistillate flowers are produced, they are quite common (Figs. 8, 9, 10). The stamens, however, are generally very much reduced or are rudimentary. The dorsal stamen seems to persist longest and will often be well developed, while the other two are

FIG. 11. THE KIND OF A TASSEL IN WHICH HERMAPHRODITE FLOWERS ARE VERY COMMONLY FOUND.

[3] *Bulletin of the Torrey Botanical Club*, 1894, p. 336.

rudimentary (Fig. 9). The lodicules are very prominent in the staminate flowers, and will usually be found more or less reduced in hermaphrodite flowers, but they entirely disappear in the pistillate flowers.

FIG. 12. PISTILLATE FLOWER OF DENT CORN, very young, carpel not yet closed. *r*, Rudimentary lower flower magnified 65 diameters.

The lower rudimentary flowers may be found in the pistillate flowers of all types of cultivated corn (Fig. 12). The abortive ovary is soon absorbed, but the palet and glume remain to form a part of the 'chaff' on the ordinary corn cob.

The development of the central spike into an ear may now be easily traced. First, the pedicellate spikelet in each pair of spikelets becomes sessile so that we have a pair of sessile spikelets as in Fig. 5, *c*. Then the upper flower in each spikelet becomes a perfect pistillate flower, while the lower flower in each spikelet becomes an abortive pistillate flower. The pairs of spikelets on the central spike are in four to eleven or more rows, so that by the mere development of the central spike of the tassel into

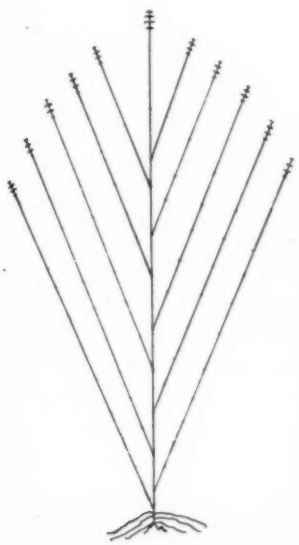


FIG. 13. DIAGRAM ILLUSTRATING PROBABLE STRUCTURE OF EARLY PROGENITOR OF CORN PLANT.

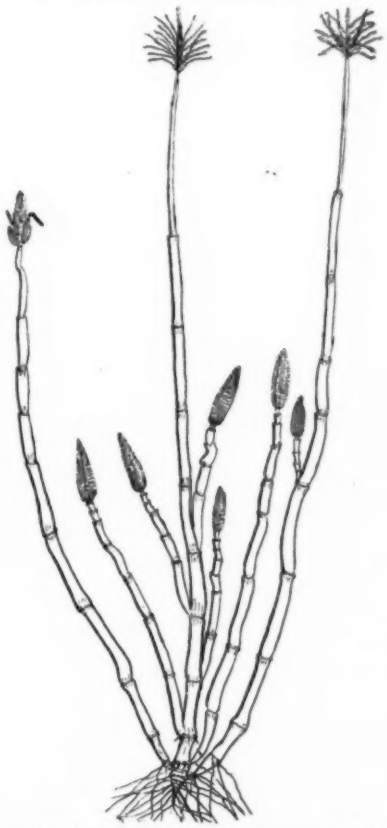


FIG. 14. DRAWING FROM PHOTOGRAPH OF A SWEET CORN PLANT TO COMPARE WITH DIAGRAM FIG. 13. Note that the number of nodes in the shortened ear-bearing branches corresponds exactly to the number of nodes in the main stem above point of attachment.

a pistillate spike, we have an eight to twenty-two-rowed ear. This accounts for the well-known fact that corn ears are *even* rowed.

My observations suggest to me that corn and teosinte may have had a common origin, and that in the process of evolution the cluster of pistillate spikes in teosinte were developed from the *lateral* branches of a tassel-like structure, while the corn ear developed from the *central* spike. It is probable that the progenitor of these plants was a large much-branched grass, each branch being terminated by a tassel-like structure, bearing hermaphrodite flowers. Fig. 13 is a diagram of such a plant. As evolution progressed, the central tassel came to produce only staminate flowers, these being higher and in a better position to fertilize the flowers on the lower branches. At the same time, the lateral branches came to produce only pistillate flowers, their position not being favorable as pollen producers, while, on the contrary, they were favorably placed to receive pollen. This differentiation in the flowers was accompanied by a shortening of the internodes of the lateral branches until they were entirely enclosed in the leaf sheaths, as shown in Fig. 1.

Fig. 14 is a sketch of the stalk and ears of a well-developed sweet corn plant after the removal of the leaves and leaf sheaths. It will be noted that the number of nodes in the ear-bearing branches agrees exactly with the number of nodes found in the stalk, above the point of attachment. If these branches were elongated to their normal length, we should have something similar to the diagram in Fig. 13. The lowermost branches usually arise at or below the surface of the soil. They develop their own root systems where they are in contact with the soil, and soon separate from the main plant and become independent plants bearing a proper tassel and ear, in all respects similar to the parent plant. Intermediate between the tassel-bearing branches and the first ear-bearing branches on the main stem there often may be found one or more branches, the tendencies of which seem to be about equally divided between ear-bearing and tassel-bearing, resulting in a structure combining the characteristics of both tassel and ear.[4]

[4] I wish to acknowledge indebtedness to Dr. Charles E. Bessey for helpful advice during the course of this investigation.

SPENCER FULLERTON BAIRD

By T. D. A. COCKERELL[1]
UNIVERSITY OF COLORADO

SPENCER FULLERTON BAIRD was born at Reading, Pa., on February 3, 1823. He was the third child, as well as the third son, of Samuel Baird and Lydia Biddle Baird. Samuel Baird was a lawyer and a man of education and scholarly tastes, very much interested in natural history in a general way, although he could hardly be called a naturalist. He died when S. F. Baird was only ten years old; but it was from him, in those early years, that the latter got the original impulse toward the study of natural objects.

Professor Baird's ancestry, as we learn from Dr. Brown Goode, was English on one side; on the other Scotch[2] and German. His paternal grandfather was Samuel Baird, of Pottstown, Pa., a surveyor by profession, whose wife was Rebecca Potts. The Bairds were from Ireland, while the Potts family removed from Germany to Pennsylvania at the close of the seventeenth century. His great grandfather on the mother's side was the Rev. Elihu Spencer, of Trenton, who was one of the war preachers of the Revolution, and was so influential that, according to tradition, a price was set on his head by the British government; his daughter married William M. Biddle, a banker of an English family for many generations established in Pennsylvania.

After the death of Professor Baird's father, his mother, with her seven children, moved to Carlisle, the county seat of Cumberland County, Pa., where her nearest relatives were then living. Young Baird was educated at the grammar school at Carlisle, and at Dickinson College, in that city; graduating from the latter at the age of seventeen. The boys of the Baird family were all interested in shooting; but the oldest, William McFunn Baird, and the subject of the

[1] I am greatly indebted to Miss Lucy H. Baird for information, for access to portions of Professor Baird's diary, and especially for some unpublished notes for a memoir of her father, written by herself. The last, with her kind permission, has been freely used and incorporated in the present work. I am also much indebted to the authorities of the Smithsonian Institution for permission to examine Baird's letter-books; and to Drs. Dall, Ridgway, Gill, Mason and others for much kind help. I have also availed myself of the published memoirs of Baird, especially that of Dr. Brown Goode, with the accompanying bibliography (Bull. 20, U. S. Nat. Museum).

[2] Properly speaking, 'Scotch-Irish,' *i. e.*, from Ireland, but of Scotch blood.

present memoir at a very early age became interested not merely in killing birds, but in studying them. These brothers in their early 'teens' began to form a collection, of which they were joint proprietors. This was really the nucleus of what is now the National Museum series, and possesses a historical interest in relation to the museum similar to that possessed by the Sloane collections in relation to the British Museum. It is said that some of the early specimens were prepared 'by the simple process of evisceration, followed by stuffing the body-cavities full of cotton and arsenical soap'; but the later ones were admirably prepared, and all are alike precious to those who are interested in the foundations of American ornithology.

Spencer Baird was ready to enter Dickinson College a year before he actually did so; but Miss Baird informs me that he used to say that he regretted that he had not been kept back longer, as he thought that a boy of thirteen was mentally too immature to reap the full benefit of a college course. The opportunities for scientific study in the college were, of course, very small in those days; but there is no doubt that Baird at this time had fully acquired the 'scientific spirit,' and all he needed was reasonable opportunity. His diary, beginning in 1838, when he was only fifteen years old, shows the same close observation and painstaking exactness which characterized the work of his later years. Thus we read on May 25, 1839:

About one A.M. gust came up; light wind—some thunder—rained violently for one quarter hour. Very warm all day. About two P.M. went out to creek with gun. Shot some small birds, principally flycatchers. Home at seven. Skinned and opened birds until ten.

Another entry in the diary reads:

15th, Saturday. Rode part of way home; shot six robins, young and old, under mulberry tree; warbling vireo; read-head, and downy woodpecker.

A later note, dated December 1842, states that the last-mentioned woodpecker was apparently a distinct species, and was named after Baird by J. G. Bell, of New York.[3] 'It was on a high horizontal limb in the first bottom.'

Dickinson College must have been somewhat in advance of the times, for lectures on zoology were offered. The diary under June 18, 1839, has the record, 'Attended one of Mr. Hamilton's lectures on zoology to the senior class in the afternoon.' Baird was then a junior, but no one could deny his fitness to rank with the seniors in zoology.

After leaving college, Baird continued his natural history studies with unabating zeal, and it is evident that at this time his mission in

[3] **It was, apparently, never published. I could find no reference to it, and Dr. Ridgway, to whom I applied for help, is also unaware of any such bird having been published.**

life was fully decided, though this was not so apparent to his relatives as it now is to us. It must be remembered that in 1840 zoology had not received the recognition in America as a serious and important branch of study that it has to-day, largely as the result of Baird's work. There was no great National Museum; there were no zoologists occupying important and enviable positions; there were hardly any opportunities for the publication of zoological work. It is not surprising, therefore, that young Baird's ultra-devotion to this subject was regarded with somewhat modified approval. Here was a young man, manifestly talented and able to make his way in the world, giving himself over to birds and beasts, snakes and salamanders; things which were very well to occupy the leisure moments of a gentleman, but were not calculated to bring either fame or fortune! Nevertheless, Baird went his way, for he could not do otherwise; and even in those days he had a staunch supporter in his grandmother, while his mother was too wise to interfere with his plans.

However, it appeared necessary to select a profession of some kind; and, like so many other naturalists, he became a medical student. In 1841 we find him going to New York, where he lived during one winter, part of the time with Dr. Middleton Goldsmith, and attended a course of lectures at the College of Physicians and Surgeons. He never formally completed his medical course, but in 1848 he received the degree of M.D., *honoris causa,* from the Philadelphia Medical College. Baird's life in New York is told in brief paragraphs in his diary. I made the following extracts:

Saturday, 6th. In evening with Dr. Goldsmith to see Mr. Audubon. Found him unlike my preconceived idea of him.

Audubon was, of course, at that time *the* ornithologist in this country, and Baird became his legitimate successor in the science. The first meeting (it appears that they had previously been in correspondence) led to an almost immediate intimacy, as the dairy shows:

8th, Monday. Heard Watts on osteology, and Torrey on chemistry.

9th. Round to Mr. Audubon, 86 White St., to see his exquisite drawings of quadrupeds, all finished size of life. Helped Dr. Goldsmith dissect a fox-squirrel for Mr. Audubon. Heard Dr. Torrey in evening.

12, Friday. Mr. Audubon called at the office (Mr. Goldsmith's, with whom I am staying) to see me.

He very soon became acquainted with all the prominent naturalists in New York at that time, and was well received everywhere.

23rd, Thursday. Dissecting opossum all day.

In morn went with Major Leconte to see Dr. DeKay at the Lyceum, who is preparing the State account of the Zoological Survey. He has all the animals of New York, figured. At Mr. Audubon's where saw some live *Neotoma floridana* (a species of woodrat) from South Carolina. Took some birds to

show to J. G. Bell, when met J. P. Giraud, with whom I went to see his collection of birds, which is the finest I have seen. Gave him a Cape May warbler. He gave me a Red Phalarope and a copy of his little tract called Descriptions of 16 New Species of North American Birds from Texas.

Wednesday. At Mr. Audubon's in morn for two hours, drawing.

9th, Thursday. Thanksgiving Day. No lecture. In morn at Mr. Audubon's, taking drawing lessons; started with *Tyrannula*.

Although he took lessons from so great a master, he never became very skilled with the pencil; largely, of course, because the pressure of other work prevented him from spending much time in drawing. No doubt, however, his knowledge of the minute structure of *Tyrannula*, gained in the way just described, helped him to discriminate and describe two new species a few years later.

14th. Commenced drawing Cedar Bird at Mr. Audubon's. He is drawing common rabbit.

18th. Mr. Audubon gave me a copy of the letter press of his Biography of Birds, five volumes, royal octavo. Obtained a number of rare American bird skins from Peale, for which I am to send Helices, fossils, coins etc.

28th, Thursday. Went down to the Thomas P. Cope Liverpool Packet to see Mr. Nuttall, who is about starting for England. He has inherited an estate of $5,000 per annum, at Prescott, near Liverpool. He invited me to come and see him at it.

Mr. Nuttall was, of course, the distinguished botanist and ornithologist. Circumstances never permitted the acceptance of the invitation.

Baird now went to Philadelphia for a short vacation:

29th. Went with Mr. Woodhouse to Mr. John Cassin's.

The veteran ornithologist Woodhouse only died recently. Cassin became one of Baird's most intimate friends, sharing with him in the interest of every ornithological discovery. The old colored man, Mr. Solomon Brown, who faithfully assisted Baird during his whole life in Washington, tells me that 'old John Cassin used to come down from Philadelphia about once a month to look over the collection; and he and Baird were just like brothers.'

To return, however, to the diary:

30th. In morn at T. A. Conrad's. Saw a fine collection of Siberian fossils.

31st. Took tea with Dr. and Mrs. Marshall at Isaac Lea's. Saw his very extensive collection of fossils and shells.

This also was in Philadelphia. Conrad and Lea were the famous conchologists, Lea being especially devoted to the freshwater mussels.

Baird was certainly not one of those people who wait for opportunities to engage in research. He not only went everywhere and met every naturalist within reach, and picked up all the information he could from them and from books, but he was making discoveries on his own account. Although he is known to us as a student of vertebrate zoology, he took a keen interest in botany, anthropology and many

other subjects. The diary of January 17, 1844, has this item: 'Commenced making extracts from Torrey and Gray's Flora.' He needed the use of a microscope, and this was loaned to him by Dr. Haldeman, the well-known naturalist, who befriended him in many ways. In 1844 we find him visiting Dr. Melsheimer, the coleopterist. The year 1843 was one of great activity in field research and collecting. The diary says: 'Walked about 1,400 miles this year. Used about 70 lbs. shot, 8 lbs. powder, and 1,800 caps.'

Not only did Baird add much to what was known of the distribution and characters of the birds and quadrupeds of Pennsylvania, but five entirely new ones were discovered in the vicinity of Carlisle, namely, two birds, a lizard, a frog and a salamander. The birds were the yellow-bellied and least flycatchers; they formed the subject of Baird's first published paper, which appeared in the *Proceedings* of the Academy of Natural Sciences of Philadelphia, in 1843. This paper, which was the joint product of the brothers, William and Spencer, was entitled 'Descriptions of Two Species, supposed to be New, of the Genus *Tyrannula,* Swainson, found in Cumberland County, Pennsylvania.' The birds were named *Tyrannula flaviventris* and *Tyrannula minima,* and are to-day well-known species; they are now placed in the genus *Empidonax,* to which Baird subsequently removed them.

The salamander, *Pseudotriton montanus,* was published in 1849; it is now known as *Spelerpes ruber montanus* (Baird). The lizard, published in the same year, is *Eumeces anthracinus* (Baird), while the frog, not published until 1854, is known as *Chorophilus feriarum* (Baird). It will be admitted that these were interesting finds in a region so well known as Pennsylvania toward the middle of the last century; evidence that Baird was using his own eyes, and not depending too much upon the work of others. Another discovery, of somewhat later date, was an apparently extinct rat of large size, the remains of which occurred in the bone caves of Pennsylvania. This animal was described in 1857 as *Neotoma magister;* but many years afterwards a rat was found still living in Pennsylvania, the bones of which do not seem essentially different from those of Baird's animal, and it is thought by some that the two are identical. This was the only fossil animal ever described by Baird.

In 1844 the Baird brothers published a second paper, a 'List of Birds Found in the Vicinity of Carlisle, Cumberland County, Penna., about Lat. 40° 12′, N. Lon. 77° 11′ W.,' which appeared in the *American Journal of Science and Arts.* It is characteristic of Baird's love of precision that he should cite the latitude and longitude in the title. The list enumerated 201 species observed by the brothers, with particulars about their time of appearance, abundance, etc. In 1845 a revised edition appeared, enumerating 202 species from the county,

and revising the nomenclature of seven species, to bring it in accord with the strict law of priority. This edition was by S. F. Baird alone, William Baird having entered upon the practise of law, and given up active participation in scientific pursuits.

It is said that a prophet is likely to be without honor in his own country; but Baird was one of those rare men who, without pushing themselves forward, succeed in enlisting the sympathy and support of all those about them. An amusing story is told, that once he was engaged in hunting for Indian arrow-heads and other remains in a field, and some men working in an adjoining field stopped to see what he could be about. After watching him for some time, they concluded that he was an escaped lunatic, and, procuring a rope, approached with the intention of capturing him. Baird, looking up, saw them coming, and immediately began to exhibit to them his finds, and explain about the past history of the Indian tribes. In a moment, he was giving a lecture on anthropology to a thoroughly interested and admiring audience, and it is reputed that some of them subsequently took up the same study. Similarly, the doubts which may have been entertained by his family and friends faded away, and Dickinson College, in his own home town, was glad to elect him professor of natural history in 1845, when he was but twenty-two years of age.

The appointment at first was little more than a token of regard, for there was no pay and there were no duties assigned. Both, however, began simultaneously in 1846; and in the same year he married Miss Mary Helen Churchill, the only daughter of Sylvester Churchill, Inspector General U. S. A. It is perhaps not unfitting to cite here the remark of old Mr. Solomon Brown, that "Baird was as near a perfect man as I ever met with, and I do not see how such a man could get a wife equal to himself; but that is what he did, for she was as sweet as he was," and, added Mr. Brown, "I never saw either one angry."

Baird as a teacher was indefatigable and resourceful. He had nothing resembling the luxurious laboratories of to-day, and it was necessary for him in many instances to manufacture his own apparatus. It was scarcely possible at that time to find text-books covering the necessary ground; but, in any event, it was no plan of Baird's to study books to the exclusion of out-of-door nature. Whenever it was possible, chiefly on Saturday afternoons, he took those of his classes who cared to join him on long walking trips in the neighborhood of Carlisle, botanizing, geologizing and collecting the mammals, birds, fishes and reptiles of the neighborhood. Several of the students so trained afterwards went as collectors with various exploring parties, and did good service in procuring material for the National Museum. In 1848 Baird applied for and obtained a grant from the Smithsonian Institu-

tion (then recently established) for the purpose of working up the natural history of southeastern Pennsylvania, and especially for the exploration of the bone-caves already mentioned. This was the first grant for original research made by the Smithsonian; no large amount, but wisely and well bestowed.

In 1850, Professor Henry, the secretary of the Smithsonian Institution, requested the regents to allow him to appoint an assistant secretary in the department of natural history, to take charge of the embryo museum, and to aid in the publication and other interests of the establishment. This being granted, he at once selected Professor Baird, who immediately accepted and entered upon his new duties.[4] In doing so, he brought to the museum his own valuable collections, and from that time until his death devoted himself absolutely to performing and assisting scientific work on behalf of the American people.

The dream of Baird's life had been the creation of a museum, and to this end, as far as the policy of the Smithsonian Institution would permit, he bent his energies. The situation was a difficult and a delicate one, and we marvel that he was able to completely gain his ends without friction or controversy. Professor Henry, in organizing the Smithsonian, performed an exceedingly difficult task with skill and wisdom. There were all sorts of rival claimants for the disposal of the fund, some wishing to have literature provided for, others different branches of science, and many desiring that the money should be put into a large library. It was perfectly evident to Henry that, if he listened to all these demands, the Smithsonian fund would be frittered away and nothing of much consequence accomplished. He therefore laid stress on Smithson's terms of bequest, in which it was stated that the institution should be for the increase and diffusion of knowledge, and opposed the numerous elaborate plans presented to his notice. It was no part of Henry's intention, when he secured the employment of Baird, that the latter should build up a great National Museum; yet this was the very thing that Baird desired and hoped to do. Both men were right in the light of what they knew; the museum plan would probably have wrecked or crippled the Smithsonian in the hands of any one but a genius like Baird; but as it was, it gradually and naturally evolved, finding for itself public support, and in due course meeting the full approval of Henry himself. Those who were intimately acquainted with the two men speak only of their great attachment to one another, and the total lack of friction in the details of administra-

[4] In Marcou's 'Life of Agassiz,' Vol. II., p. 74, the matter is presented in a somewhat different way, but not quite accurately. For example, as I learn from Miss Baird, Geo. P. Marsh was a member of the House of Representatives, not a senator; and he was acquainted with Baird prior to 1848. Furthermore, Henry was of course well aware of Baird's existence and his qualifications.

tion. In this and numerous other cases, Baird's success was due not to any form of cunning, but rather to his straightforward simplicity and manifestly unselfish devotion to his work.

In Baird's first report as assistant secretary, published in 1851, he called attention at some length to the important work needing to be done in zoology, botany and geology. It was the declared policy of the Smithsonian, at that time, not to attempt to cover the whole field of science, but to attend to those subjects which had been neglected by others. Very well, said Baird: accepting fully this plan, we must point out that we lack information on—and he proceeded to specify in detail the very numerous investigations crying out for workers, and the splendid opportunities that lay before those who should take them up.

He was by no means content to work solely through official channels. In every possible way he stirred up the enthusiasm of collectors, aided those who desired to study and persuaded travelers to secure material for the museum. When going through his letters of the year 1859, I found evidence of his wonderful perseverance which is worth citing. In March of that year he wished to send the well-known naturalist and traveler, Robert Kennicott, to the region of the Hudson Bay for specimens. The Smithsonian had absolutely no funds for such a purpose, and with any ordinary official that would have settled the matter. Not so with Baird; starting a subscription list with fifty dollars out of his own pocket, he wrote to most of the prominent naturalists of that day, asking them to subscribe what they could and receive a corresponding part of the collections. The response was prompt and satisfactory, and about $500, the amount asked by Baird, was raised. I have before me a copy of the list of subscribers containing such well-known names as those of Cassin, Brevoort, Lawrence, Ostensacken, Cresson and Lea. The Smithsonian itself did finally put in $50, in addition to the sum personally subscribed by Baird on its behalf.

About the same time Baird wished to send John Xantus, a Hungarian resident in America, and a skilled naturalist, to the little-known peninsula of Lower California. It was evidently impracticable to raise two five-hundred dollar subscriptions; but Xantus must go. It was ascertained that the U. S. Coast Survey wished to send a man to that region to examine the tides; why not Xantus? So it was readily arranged, and off he went, furnished with all facilities for collecting specimens.

Thus, without any visible resource to begin with, two important expeditions were despatched. Those who know something of the zoology of America do not need to be reminded of the great results accomplished in each case. It is hardly possible to open a work on any large

group of American animals without finding references to the fruits of those two expeditions.

If Baird asked contributions from residents in distant parts, it was all for the sake of science, as they well know; yet he at his end did not spare himself in serving the personal needs of his correspondents. At one time we find him going out to purchase shoes for a whole family in Costa Rica; at another, Mrs. Baird's cooperation was secured in the selection of a 'lady's silk,' intended for the wife of a resident in a far northern post. It was no easy matter to select the cloth, not even knowing the color of the lady (she turned out afterwards to be a half breed), but the purchase was entirely satisfactory.

Baird only entered upon his labors at the Smithsonian in October, 1850, but a year had not passed before he received important and abundant materials from the west. The following letter to the distinguished botanist, Dr. George Engelmann, of St. Louis, Mo., is sufficiently characteristic:

SMITHSONIAN, WASHINGTON, Sept. 30, 1851.

Dear Doctor:

The box arrived safely during my absence, and on my return a few days ago I hastened to open it. I was enchanted out and out with the perfection of the packing, and the interest of the contents, which greatly exceeded my anticipations. Much obliged to you for the trouble you had.

I am glad that you are at work for Agassiz and myself. Make a big collection, and don't spare the liquor. Remember we want everything. Keep Lindheimer spurred up [Lindheimer was a well-known botanical collector who traveled in Texas]. Shall I send him some money, and how much; also what kind passes there.

Specimens coming in rapidly. I collected many myself and have as many sent me. Let me know how I can serve you, and believe me ever yours,

S. F. BAIRD.

Then again, to the accomplished collector, Arthur Schott, then at Eagle Pass, Texas:

SMITHSONIAN INSTITUTION, WASH., May 15, 1852.

My Dear Sir:

In a letter under date of Frontera of April 10 just received from Major Emory, he was kind enough to say that he had requested you to make some zoological collections on the Lower Rio Grande and forward them here,—or at least would do so. I was much pleased to learn of the stationing so accomplished a collector as yourself in this rich region, and doubt not that you will make the position tell greatly to the advantage of natural history. You, of course, need no especial instructions in regard to the mode of collecting the objects to be gathered. In so a virgin a field as the one you are now in, everything without a single exception is desirable.

My first favorites are as you well know, vertebrata, fishes and reptiles perhaps above all, mammals and birds, however scarcely behind. . . .

On April 2, 1853, he writes to Dr. Engelmann:

I think all the western parties will go provided with naturalists. There will be a most enormous mass of matter brought in this year from the west.

In March, 1857, he writes to Dr. F. Brandt, of St. Petersburg, relative to an exchange of specimens desired by the St. Petersburg Academy. After dealing with the matter of the exchange, Baird writes:

> In the enormous activity of the parties in connection or correspondence with the Smithsonian Institution, the number of species of North American Vertebrata has increased very largely in the last few years. Thus while Dr. Holbrook's work on our reptiles enumerated about 160 species of North American reptiles, we already possess nearly 400. Of fishes Dr. Girard described a few months ago about 50 species of Cyprinidæ alone from the region west of the Mississippi. We have nearly 200 species of birds not mentioned by Audubon, while of quadrupeds I have already determined about 60 species not given by Audubon and Bachman. It is here indeed that our collections show best, the addition having been at the rate of 1,000 per year for two years, not counting the small species in alcohol. The additional species embrace about 12 sorices, one *Urotrichus*, many Spermophiles, and squirrels, species of *Ursus*, *Felis*, *Cervus*, *Taxidea*, etc. Of every North American mammal we possess one or more skulls, except of *Enhydris marina*, *Capera montana*, *Gulo luscus* and *Ovibos moschatus;* the first and third of these we expect in a few months.[5]

No expedition was allowed to start out under government auspices without one of Baird's missionaries, as he called them, or, if that was impracticable, some one of the party being equipped with the apparatus for collecting and preserving specimens. Even John Howard Payne, the author of 'Home, Sweet Home,' when he went to take up his duties as consul, was supplied with copper tanks, alcohol and dip nets, with which he faithfully promised to secure a collection of Tunisian fish.

Every effort was made to enlist the services of occasional correspondents who wrote to the Smithsonian for information. A letter giving the particulars desired would perhaps have a postscript asking whether there were any Indian remains to be found in the locality where the correspondent lived, or whether there was any one who could be induced to make a collection of fish, reptiles, birds, etc. In a great many instances these letters bore important fruit, and any efforts made to comply with the requests would be received with such courteous expressions of approval, often backed up by Smithsonian reports or other literature bearing upon the subject, that the collector would before long become zealous in doing his part for so appreciative an institution. It was in this way that with the expenditure of very little money—for there was little money available for the purpose—the collections of the Smithsonian grew. It is probable that Baird's courteous manner toward all correspondents had a good deal to do with forming the custom which now prevails in the scientific departments in Washington, of promptly supplying every serious enquirer with information, and, if necessary, with publications. This useful and enlightened policy is

[5] The letter, as copied, is in a few places indistinct, but Dr. Gill has kindly interpreted the few difficult passages.

now thoroughly established in our government service, and is one of the most conspicuous marks of the superiority of our scientific bureaus over those of many nations. I have ventured to select two of Baird's letters to previously unknown correspondents as examples of his method. The first is to the sender of a hair-worm, that animal which most naturalists have learned to abhor because of the frequency with which they are called upon to explain its nature. Many of us, I fear, would have sent a curt reply, but not so Baird:

June 28, 1853.

Dear Sir:

The specimen you send is one of Gordius or hair-worm, a very interesting entozoon. The fact you mention of its crawling from the body of a cricket is very interesting as tending to settle the question whether the Gordius crawls into or out of the animal it infests. The association between the two has long been known, but every available fact bearing on the subject is of great value.

Yours truly,

S. F. BAIRD.

S. N. SANFORD, ESQ., Granville, Ohio.

Dr. Ridgway has elsewhere published (Smithsonian Report for 1888, p. 711) his first letter from Baird; here is the first letter to E. D. Cope:[6]

March 27, —58.

Dear Sir:

I was much pleased to receive your letter this morning and to see the minuteness of your knowledge of the Batrachia of Penna. I would be glad to know how extensive your herpetological studies have been, whether covering other branches than the Batrachia anoura, and whether you have gone at all into other classes.

In reference to your Hylodes . . . I can not without a reference to our specimens (at present somewhat inaccessible) decide. It appears, however, much like some dark varieties of the *Hyla pickeringii*. In a paper enclosed you will find description of some new frogs, one, *Helocætes feriarum* hitherto only observed near Carlisle. I make the *Hylodes pickeringii* a *Hyla*, as I can not distinguish it generically. Of course not congeneric with *acris*. What do you mean by *Hylodes* . . .? This may be the *feriarum*.

If your time is at your own disposal, it might be worth your while to visit Washington, and examine our Herpetological collections, which are of extraordinary richness. Our specimens of North American serpents number over 600 specimens and about 140 species.

It will always give me pleasure to hear from you and to render any assistance in my power to your studies.

Truly yours,

SPENCER S. BAIRD.

E. D. COPE, care J. B. Garrett.

As the new material came in to the museum from all directions, it had to be taken care of and worked up. It is difficult to understand how Baird avoided being literally buried beneath the pile of accessions.

[6] I omit the specific names which Cope appears to have given to the two frogs referred to, as they seem not to have been published.

In the earlier years there was very little help to be had, even of a purely mechanical sort, and he did most of the work with his own hands and with the aid of such friends as he could impress into the service. He was even obliged to pack up the Smithsonian exchanges; and for many years all his official letters were in his own hand. The first assistant curator of the embryo national museum was (speaking in wholly unofficial language) Mr. Solomon Brown, already mentioned. Appointed about two years after Baird took charge, for the purpose of assisting with the Smithsonian exchanges, this excellent colored man soon learned to skin animals and prepare skeletons, and was for nearly forty years Baird's right-hand man. If the assistance given by Brown lightened one side of the work, the other grew rapidly heavier, and for years it must have been a constant struggle for Baird and his few associates, such as Dr. Girard, to sort and label the specimens, and carry on the official correspondence. As one contemplates the old records, and remembers what was actually done and who there was to do it, it seems amazing that the mere routine work of the museum could be successfully carried on, and if ever a man had a valid excuse for not engaging in original research for lack of time surely that man was Baird. Original research, however, was the purposed end of all the accumulation. The materials obtained must be worked up and that with as little delay as possible. Baird was perfectly willing and glad to see this done by any competent person, but while securing cooperation wherever he could, he put his own shoulder to the wheel, and produced in rapid succession a series of works of the first importance.

This seemingly impossible achievement was due to the way he worked, after hours, during meals, and in fact to the limit of his capacity. Solomon Brown describes him to me as taking his coffee with one hand while he held his notes in the other; he could not stop even to eat. For nearly twenty years he kept this up; but after 1870 his executive duties having become very heavy, and the young men he had trained being well in harness, he ceased to engage in active research. That he felt obliged to do so, no naturalist can help regretting; for though it would be impossible to exaggerate the importance of his labors as head of the Smithsonian and Fish Commission, it is equally impossible to forget what we have lost in the way of illuminating investigations of our vertebrate fauna. It need not be considered an affront to those who came after him, to suggest that if Baird's time had been his own several groups would be in better order than they are to-day.

The task which Baird accomplished was, in brief, the putting in order of the mammals, birds, reptiles and amphibians of the North American continent, with the description of very numerous new species

of these and of fishes. It will be well to give a brief summary of his labors:

Mammals.—The eighth volume of the *Pacific Railroad Reports,* published in 1857, is a large quarto of more than 800 pages, devoted to a complete revision of the mammals of North America, so far as the materials then available would permit. This work was much in advance of all others in the precision of the descriptions, the citation of localities and the care with which the synonymy was compiled. To this day, we have nothing that really takes its place. The matter of illustrations was not overlooked; I found among Baird's letters one dated January 24, 1852, addressed to d'Orbigny in Paris, asking how illustrations might best be made with a view to excellence and at the same time economy. What information d'Orbigny supplied I do not know, but the illustrations accompanying Baird's larger works were remarkable for their excellence, and highly creditable to the new museum.

Baird described in all sixty-three new mammals, of which forty-two are now considered valid, and twenty-one synonyms. I will confess that I was surprised at the large amount of synonymy; but it must be remembered that in the fifties large series for comparison, such as are available to-day, did not exist, while the descriptions of earlier writers were many of them imperfect. Nine genera and subgenera were proposed, of which seven are accepted to-day.

Birds.—I can not do better than quote the statements (Smithsonian Report for 1888, pp. 706–708) of Dr. Robert Ridgway, who more than any other man is to be regarded as Baird's successor in this field:

> With the publication, in 1858, of (the Pacific Railroad Report on The Birds of North America) a great quarto volume of more than one thousand pages, began what my distinguished colleague, Professor Coues, has fitly termed the 'Bairdian Period' of American ornithology—a period covering almost thirty years and characterized by an activity of ornithological research and rapidity of advancement without a parallel in the history of the science. Referring to this great work, in his 'Bibliographical Appendix' to 'Birds of the Colorado Valley' (p. 650), Professor Coues says: "It represents the most important single step ever taken in the progress of American ornithology in all that relates to the technicalities. The nomenclature is entirely remodeled from that of the immediately preceding Audubonian period, and for the first time brought abreast of the then existing aspect of the case. . . . The synonymy of the work is more extensive and elaborate and more reliable than any before presented; the compilation was almost entirely original, very few citations having been made at second-hand, and these being indicated by quotation-marks. The general text consists of diagnoses or descriptions of each species, with extended and elaborate criticisms, comparisons, and commentary. . . . The appearance of so great a work from the hands of a most methodical, learned, and sagacious naturalist, aided by two of the leading ornithologists of America (John Cassin and George N. Lawrence), exerted an influence perhaps stronger and more widely felt than that of any of its predecessors, Audubon's and

Wilson's not excepted, and marked an epoch in the history of American ornithology. . . . Such a monument of original research is likely to remain for an indefinite period a source of inspiration to lesser writers, while its authority as a work of reference will always endure."

Thus are graphically described the distinctive feature of what Mr. Leonhard Stejneger has truthfully termed the Bairdian School of ornithology, a school strikingly characterized by peculiar exactness in dealing with facts, conciseness in expressing deductions, and careful analysis of the subject in its various bearings;—methods so radically different from those of the older 'European School' that, as the esteemed member whom we have just named has already remarked, conclusions or arguments can be traced back to their source and thus properly weighed, whereas the latter affords no basis for analysis. In other words, as Mr. Stejneger has, in substance, said, the European School requires the investigator to accept an author's statements and conclusions on his personal responsibility alone, while the Bairdian furnishes him with tangible facts from which to take his deductions. . . . The distinctive features of the 'Bairdian school' were still further developed by the publication in 1864–66, of the 'Review of American Birds,' a work of unequaled merit, displaying in their perfection Professor Baird's wonderful powers of analysis and synthesis, so strongly combined in his treatment of difficult problems. Unfortunately for ornithology this work was but fairly begun, only a single volume (an octavo of 450 pages) being published. . . . I have it on good authority that no single work on American ornithology has made so profound an impression on European ornithologists as Professor Baird's 'Review,' and, by the same authority, I am permitted to state that he—a European by birth and rearing—became an American citizen through its influence.

Dr. D. S. Jordan writes, concerning Baird's methods:

He taught us to say, not that the birds from such and such a region show such and such peculiarities, but that 'I have the following specimens, which indicate the presence of certain peculiarities in the birds of certain regions. The first was taken on such a day of such a month, at such a place, by such a person, and is numbered so and so on the National Museum records.

This habit of exactness, introduced by Baird (who himself exhibited it, as we have seen, when still a boy), has been followed by most of our ornithologists, with the result that this subject has been brought to a remarkable degree of completeness. Let any one compare the current literature on birds with that on insects, and the immense influence and value of the Bairdian method will be at once apparent.

The 'Review of American Birds' described and classified a number of species from Costa Rica and adjacent countries; and Dr. Ridgway, who is now studying the birds of Costa Rica, with materials vastly more abundant and satisfactory than those possessed by Baird, tells me that he marvels at Baird's accuracy and insight. From Costa Rica alone, Dr. Ridgway has obtained from 3,000 to 3,500 birds, a greater number than Baird had from all middle America, including the West Indies; and yet Baird's work still stands, with very few modifications.

Baird described about 124 new species and subspecies of birds,[6] including a few which were published by others from his manuscripts. He established about 28 new genera and subgenera, most of which are now accepted and in current use. Quite a large number of the species are now reduced to subspecies, but this is explained by the fact that in Baird's day the trinomial system had not come into general use, and consequently binomials were used for birds which would now be considered to have less than full specific rank. It must also be remembered that the great series now available show intergrading forms which were not known fifty years ago. A certain number of synonyms were based on individual variations and immature states of plumage, and in one case a bird proved to be Asiatic, with a wrong locality. On the whole, judging by the modifications introduced by later authors, it appears that Baird's work on birds was of a higher grade than that on other groups; but it may be that this is largely to be explained by the relatively chaotic condition of the then-existing knowledge of the other classes, making the task of reducing them to order more difficult.

Batrachia.—In 1849, before he went to Washington, Baird published (*Jour. Acad. Nat. Sci. Philadelphia*) an important paper entitled 'Revision of the North American Tailed Batrachia.' In this work the nomenclature of the species was wholly revised, some new species were indicated, and the genus *Desmognathus* was established. This genus is now universally recognized, and Cope has made it the type of a distinct family, Desmognathidæ. Papers on Batrachia, containing descriptions of new species, and a few new genera, continued to be published until 1850, most of them in conjunction with Dr. Girard. After that date, in 1867, 1869 and 1889, a few species were published by Cope from Baird's manuscript. In all 42 species and varieties were published as new, and of these 26 are recognized as valid by Cope in his revision issued in 1889.

Reptiles.—Dr. W. H. Dall ('Smithsonian Report' for 1888) writes thus:

> Many of his herpetological papers were elaborate studies. One of the most important of the early memoirs was that on the reptiles of Stansbury's expedition to the valley of the Great Salt Lake, and another, that on those collected by the United States exploring expedition under Wilkes. The catalogue of North American Reptiles in the collection of the Smithsonian Institution is a classical work, serving to the present day as a text-book for students of herpetology. In 1859 appeared his great study of the reptiles collected by the parties engaged in the explorations for a Pacific Railroad, a monument of patient research and discriminating analysis. After this his contributions to the subject were mostly short papers or announcements of new or interesting facts.

[6] Dr. Brown Goode (Bull. 20, U. S. N. M.) says 70, but searching the literature I have found a large number of additions.

Nearly all of this was the joint work of Baird and Girard, but Baird alone published a paper describing many new lizards in 1859. I find that 28 genera and about 120 species were introduced as new; of these, 11 genera and 34 species have been treated by Cope as synonyms.

Fishes.—Aside from the popular and economic work, Baird published descriptive works on fishes during the years 1853 to 1855, almost all the work being done jointly with Girard. Fifty-seven species and subspecies were proposed; 34 of these stand to-day as valid, according to Jordan and Evermann. Of six genera proposed as new, three stand as proposed, and a fourth as a subgenus. Most of the work relates to fresh-water fishes, but in 1854 Baird spent an eventful six weeks on the coasts of New Jersey and Long Island, and subsequently published a list of the marine species obtained. It is surprising to find that as the result of so brief an examination of such a supposedly well-known region it was possible to announce a new genus and seven new species. Two of the species have proved not valid, but the others are good, and no less than three of them have been made by Gill the types of new genera, making, with the genus described in the paper cited, four new genera as a result of the six weeks' work.

It must not be imagined that invertebrate zoology, botany, anthropology and other kindred subjects were neglected. Baird had a good general knowledge of all these, and, in particular, made himself familiar with the different workers all over the country, and sought their cooperation. Thus in his hands the museum actively prompted many branches of science, and a broad and stable foundation was laid. Dr. W. H. Dall, in *The Nation* of December 1, 1887, has eloquently described this phase of Baird's activities, and I can not do better than to quote his words:

> To make this policy (of wide cooperation) a success, such as it eventually became, required qualifications of no ordinary kind. Not only must the work of mediation be guided by the most advanced biological science of the time, but the individual intrusted with it must possess a spirit of impartial liberality, tempered by a sound discretion in business methods; a thorough knowledge and just estimate of men; an untiring patience to meet the peculiarities and caprices of the independent, and often one-sided specialists, whose cooperation was essential; a geniality to enlist the willing but unscientific colaborer; and an instant detection of humbug in every guise. Providentially for the future of natural science in this country, the need and the man met in the selection of Professor Baird. In qualifications for the work he stood preeminent—head and shoulders above any man of his time, and perhaps above all the scientific men of any time. He joined to a marvelous faculty for systmatizing business a capacity for study and continuous work only limited by his waking hours. His frank, genial and wholly unaffected manner put the scientist and the laboring man alike at ease. Always busy, he yet always seemed to have time for a friendly chat with every comer. His memory appeared an inexhaustible store-

house of facts on every subject where any desired datum lay ready to his hand.[1] He knew every specialist in the country. Not only did he hold amicable relations with scientists actually at work, but one might think there was not a schoolboy of extraordinary genius for bird's-nesting or fishing whom he could not lay his hands on . . . If he guided the activity of others as one would use impersonal agencies in the pursuance of a definite end, he was not less exacting with himself. He not only offered freely to others, sometimes constructive rivals, the raw material of research which he collected, but in many cases he put in the hands of those whom he thought worthy, his own more or less elaborated manuscripts, to use in their investigations, thus waiving his own priority in the field. His insistence on giving full credit to collaborators of every degree, both in publication and in records, labels, and reports, was proverbial. To the tyro treading with uncertain step the entrance ways of science he was ever cordial; always a friend, guide and helper. While Professor Henry lived, the affectionate loyalty of Baird to his venerable chief was an inspiration to those about him. . . .

It may be imagined that in his home life Professor Baird was altogether lovable, and we can not feel that we are laying sacrilegious hands upon the veil in saying that not the least of the benefits conferred upon American science was embodied in the influence which extended from that home upon a host of boyish students gathered from year to year under the brown towers of the Smithsonian Institution, slender as to their resources, half Bohemian as to their living, let loose with little restraint in that great disjointed village, the Washington of twenty years ago.

Dr. Jordan writes in the same strain, of—

the splendid benevolent personality that made Professor Baird the 'grandfather of us all,'—always interested in the scientific work of young men, and always ready to give them any help possible in that direction.

Every Sunday evening from eight onwards Baird's house was open to scientists young and old, and these informal receptions engendered a spirit of comradeship which must have done much to make lives happy and work run smoothly. The modern Cosmos Club, serviceable as it is, can not quite take the place of that nameless association of friendly spirits.

As an example of Baird's attitude toward young men, I am permitted to relate the circumstances of Dr. O. T. Mason's first meeting with him. The Smithsonian had received some Semitic inscriptions which had lain without being unpacked for some time, nobody taking much interest in them. Mr. Mason, hearing of their arrival, went to the museum to examine them; for he had already become much interested in Semitic ethnology, and expected to make it the chief study of his life. Professor Baird received him most cordially, and placing his hand on his shoulder said, 'these things have been waiting for you for six months.' So they were unpacked and set out where they could be seen; Professor Henry came in, and the three went over them carefully, the young

[1] Solomon Brown said to me, that he never heard him say he forgot anything. —T. D. A. C.

man explaining them as well as he could in the light of his studies. When it was all over and Mr. Mason turned to go, Baird turned to him and said, 'Now I want you to give all this up.' While the young man almost gasped in astonishment, Baird continued: 'If you devote your life to such a subject as this, you will have to take the leavings of European workers. It will not be possible for you here in America to obtain the material for important researches; but—I give you the two Americas!' And Dr. Mason said to me, 'I was born again that day.' Before the young man left, Baird added an invitation to visit him at his house the following Friday; and for many years this visit was repeated on each successive Friday.

It would be impossible to select a better example of benevolent and helpful wisdom than that just described. Keen to pick out good men, wise in directing their activities, even in fields not specially his own, kindness itself in his dealings with them, it is no wonder that he gave an impetus to the study of natural history in this country which is not yet spent, and it may well be, will continue as a living influence for many generations. It was just the same in his dealings with his official subordinates, from the highest to the lowest. Every day he made the round of the departments, offering a suggestion or cheering word to each worker; and, as Dr. Ridgway tells me, there was no matter too small to excite his interest. He himself knew too much of the details of scientific research not to care about every step leading to the final results. It is just this sort of interest that distinguishes the true worker from the outsider; and fortunate it was for the growing museum that the chief could be thus a true comrade to each member of the staff.

This sympathetic attitude extended to every one about him. Mr. Pollock, who was a messenger under Baird, tells me that he was like a father to him. When Pollock had to go on some errand down town, if the day was hot, Baird would thoughtfully offer him his carriage; and if he saw him walking on the street, would stop and take him in. Baird's manners were absolutely democratic, and that without the least loss of dignity; he was thus an ideal American.

Dr. Ridgway tells me that Mrs. Ridgway often recalls the first time she ever saw Agassiz. It was in the great public hall of the Smithsonian, and Baird and Agassiz were walking side by side, each eating his lunch, while they chatted and examined the specimens. What a picture the scene would have made! Is there no artist who may yet attempt to do it justice?

When Professor Henry died, in 1878, it was inevitable that Baird should become his successor as head of the Smithsonian. Thus additional heavy cares were thrown upon his shoulders; and when, in 1882, the new building was completed, he had to superintend the reorganization of the museum, with an increased staff suited to its new oppor-

tunities. Dr. Dall told me the story of the origin of the National Museum building. The need was very great, but congress did not seem at all disposed to do anything. However, when the Centennial Exhibition was held at Philadelphia, money was loaned by the government to that city, and the congressional committee on appropriations was persuaded to agree that if the money was repaid a portion of it should go for a museum building. This was a qualified sort of promise, especially since many supposed that the money would never be seen again; but Baird was determined to make the best of it. He called together his associates, and explained the situation, adding that undoubtedly the final action of congress would depend very largely on the sort of exhibit they could make at the centennial. Under these circumstances, said he, it was for the staff to do their utmost, and he depended upon them to help him to produce an exhibit such as the people of America would be proud of. So they all worked day and night for six months or more, several of them without financial compensation, and when the exhibition was opened, every one was delighted with the result. The money was repaid by Philadelphia, the museum appropriation went through in 1879, and the building was ready for occupation in 1882. To-day it is as crowded as the old one was then, and happily another and better building is in course of erection. It is thus seen, that from first to last, it is no exaggeration to say that our National Museum owes its very existence to Baird. It is difficult to say what would be the condition of biological science in this country to-day had he not lived. It is at least probable that our credit as an enlightened and progressive nation would in this direction be very different, so greatly does a country depend upon its gifted sons!

As time went on, and the museum expanded, Baird was obliged to seek an assistant to share the administrative duties, and his choice fell upon Dr. George Brown Goode, who was already connected with the Fish Commission. In 1887 Dr. Goode was made assistant secretary of the Smithsonian Institution, in charge of the National Museum.

Baird had met Goode in 1872 on the Maine coast and had at once become greatly interested in him. Miss Baird writes:

> From the time of their first meeting, a warm personal attachment sprang up between them, which deepened every year up to the time of my father's death. From the time when Mr. Goode became associated with the museum work, my father's burdens in connection therewith greatly lessened, as year by year Mr. Goode's ability in that line developed. No cloud ever obscured their harmonious relations. I can recall but one difference between them, and that was on an occasion where some idea having been carried out in connection with the museum work in which they both felt a natural pride, each was so determined that all the credit belonged to the other, and argued so strongly, that they absolutely grew a little hot in discussing the matter! My father wished Mr. Goode to take all the credit, and Mr. Goode insisted that he had only developed what my father had directed.

My own opinion is that if my father had no other title to the gratitude of the scientific world, it would have cause to remember him with gratitude for having afforded the facilities for the development of Mr. Goode's genius, which, however, would have made itself known in time without aid.

The attention of the public had been called, at the beginning of the seventies, to the increasing scarcity of food fishes on our coasts and in our rivers. By a joint resolution of congress, approved February 9, 1871, President Grant was authorized and required to appoint a person of proved scientific and practical acquaintance with the fishes of the coast to be Commissioner of Fish and Fisheries, with the duty to promote investigation into the causes of diminution, if any, in number of the food-fishes of the coast and the lakes of the United States, and to report whether any and what protective, prohibitory, or precautionary measures should be adopted. The one man to whom the above description was applicable was of course Baird, and he was requested to assume charge of the work. This he did, and not content with merely carrying out the instructions given, he proceeded to build up a great national institution for the study of fishes in their economic and scientific relations, proving to the world that the fish-supply was capable of being largely controlled and increased, and the available food of mankind thereby increased enormously. Without going into details, the growth and work of the Fish Commission under Baird can be best described in the words of Dr. Dall—

No more emphatic object-lesson of the vital relations existing between research, as such, and the promotion of the material interests of mankind has ever been furnished to the so-called 'practical man' than that afforded by the work of the United States Fish Commission as directed by Professor Baird. Whether germane to the subject of scientific research or not, the most narrow specialist can hardly begrudge an allusion to the grandeur of the methods by which the food supply of a nation was provided, hundreds of rivers stocked with fish, and the very depths of the ocean repopulated. Typically American we may call them in their audacity and their success. The fishery boards of foreign countries, first quietly indifferent, then loudly incredulous, in due time became interested inquirers and enthusiastic followers. In a few years we may fairly expect to see the food supply of the entire civilized world materially increased, with all the benefits which that implies, and this result will in the main be owing to the unremunerated and devoted exertions of Spencer F. Baird.

Baird's writings, according to Dr. Goode's bibliography, number 1,063, this including a few republications. A very large number of titles refer to popular articles, contributed in the main to *Harper's Magazine* and *Harper's Weekly,* and republished in the *Annual Record of Science and Industry.* These articles called attention to many phases of scientific activity, usually with critical comment, and must have been important instruments of public education. There were

also numerous short contributions to *Forest and Stream,* and the *Chicago Field,* relating to the popular phases of the fish work.

Baird's incessant labor at length began to tell upon his health. Unwilling to rest, he was finally informed by his medical adviser that complete relaxation was imperative, and he reluctantly accepted the decision. Professor Langley had taken charge of the Smithsonian, and the well-beloved and trusted Dr. Goode was caring for the National Museum; it seemed that the well-earned rest might be taken in peace. It was too late, however, and realizing that the end was near, he permitted himself to be taken to Wood's Holl, to the seaside laboratory of the Fish Commission. We may fitly close the story in the words of Major Powell:

> For many long months he contemplated the day of parting. Labor that knew no rest, responsibility that was never lifted from his shoulders, too soon brought his life to an end. In the summer of the past year (1887) he returned to his work by the seaside, that he might die in its midst. There at Wood's Hole he had created the greatest biologic laboratory of the world; and in that laboratory, with the best results of his life-work all about him, he calmly and philosophically waited for the time of times. Three days before he died he asked to be placed in a chair provided with wheels. On this he was moved around the pier, past the vessels which he had built for research, and through the laboratory, where many men were at work at their biologic investigations. For every one he had a word of good cheer, though he knew it was the last. At the same time, along the pier and through the laboratory, a little child was wheeled. 'We are rivals,' he said, 'but I think that I am the bigger baby.' In this supreme hour he was playing with a child. Then he was carried to his chamber, where he soon became insensible and remained so until he was no more.
>
> He died on August 19, 1887.

INTERCOLLEGIATE CONTESTS

By Professsor JOHN J. STEVENSON,
NEW YORK UNIVERSITY

THIRTY years ago, student organizations in the ordinary college were few and on a modest scale, laying no serious burden of any sort on the members. All were purely voluntary and members alone shared in either expense or advantage. Gymnastics were recognized officially in few institutions and such athletic clubs as did exist were for amusement. College boys, like other boys, were not all stalwart, some were even 'slab-chested'; but the testimony of alumni catalogues proves that their tenacity to life was such that on the average they were very good insurance risks.

Conditions in many respects have undergone change. A college, whether the students be scores or thousands in number, seems compelled to maintain one or more teams in athletics, with frequently a glee club in addition—not in any sense for amusement or for improvement, but for contests with similar organizations in other colleges. The expense is serious, but the active members are not expected to defray it, as they 'do the work.' Others must pay the bills, either directly or indirectly, under penalty of being regarded as 'chumps' without college spirit. If means be available professional coaches are always employed for athletic teams and glee clubs. The selected few in the organizations enter upon their work as a business and undergo severe training, which requires close attention and much time—and this not during vacation periods, but during the college year, when study is supposed to demand most of the student's energy. The total money expenditure on these associations must be something stupendous; in some institutions, clamoring for funds, the amount annually handled by teams and other organizations is almost enough to endow a professorship.

These semi-professional organizations, playing or singing for 'gate money,' have damaged the morals of college students, even the morale of the colleges themselves. Heads of teams keep close watch of secondary schools, not in search of brilliant students, but in search of boys who have made 'records,' and the entrance of such boys brings joy to the student body. New York is only too familiar with the scenes of debauchery which have followed great contests, as gambling has preceded and accompanied them. It has been charged that college authorities wink at flagrant evasions of laws governing amateur contests and permit 'ringers' to appear as their representatives; but this

charge should not be made lightly, for those in responsible place are usually the last to hear of irregularities. At the same time, one who reads the sporting page of a great daily paper and considers the pettifogging disputes of committees representing contesting institutions can not resist an uneasy feeling that the lowering of morale has not stopped with the student body.

College students are quite as willing to yield to temptation as are other young men; some of them indeed, like other men, are ready to go somewhat out of their way to fall into temptation. This much must be conceded; yet no one would regard that as a ground for opening a subway tavern on the campus or for licensing a high-grade gambling outfit in the library building. Students, like others, are apt to show decided disinclination for the work in hand; yet no college official would announce that as justification for encouragement to neglect study. But to encourage membership in college organizations of to-day is to encourage neglect of study. The active members are required to maintain respectable standing in class-room work, though no ordinary man can do this, if the college course be what it is supposed to be, without interfering with his duties, which students in many places evidently think more important than studies. And the college authorities seem to agree with the students, for they permit glee clubs to sing at evening concerts near and far away; they permit teams to undergo training and to absent themselves—all in such fashion that the men must fall behind in their work, if the work be what it purports to be. Yet these men get through and all the students know it.

The incongruity of the conditions affords constant play for newspaper wit, and colleges are regarded popularly as agglomerations of associations with a teaching annex. Colleges receive great attention from the newspapers on pages devoted to sporting news, very little elsewhere except in columns devoted to wit and humor. The coach is much more important than the professor of Latin.

It is impossible for college authorities to escape responsibility for the conditions and all the evils connected with them; any attempt to evade that responsibility is, to say the least, unmanly. Intercollegiate contests are recognized as part of collegiate operations; the students' control is nominal, the institution's control is absolute. Fields for athletic sports have been provided at great cost and they are well equipped with 'grand stand' and 'bleachers'; the gymnasium with all its paraphernalia for gymnastic contests is, at times, almost as imposing as the library building; and the excellence of the equipment is set forth duly in official publications. Qualifications for active participation in the organizations are determined by the authorities who supervise the schedules of engagements and in some instances even the pecuniary affairs.

One may wonder why these college authorities, with power to stop, consent to continuance of the conditions. Many reasons are given in justification, most of them purely evasive and absurd; but there is one argument which is regarded as final and unanswerable. These contests arouse college spirit among the students; they advertise the college; they awake enthusiasm among the alumni; an important contest receives elaborate notice on the sporting page which everybody reads, and the community learns that the college exists; a glee club swings around the circle of a score of towns and proves better for advertising than if the virtues of the college were blazoned on even Gibson posters adorning fifty miles of fences. No one was surprised to read a telegram one day in November last to the effect that the Association of Presidents of State Universities at its Washington meeting tabled 'a resolution—deploring the brutality, and waste of time resulting from the game [football] as now played.'

It may be said that, as a rule, parents are not only willing, but are also gratified, to find their sons prominent in these organizations; but the vast majority of parents know nothing about college work and they confide in the wisdom as well as in the integrity of the men to whom they have entrusted the education of their sons. There is no room for casuistry here. If a school of business should encourage students to glorify it by contests which might lead to paralysis of the right hand, or if a divinity school should provide opportunities for contests which might induce permanent injury to the voice, the press would comment at least unfavorably upon the wisdom of those in control. But technical schools, preparing men to be civil, mechanical or mining engineers, encourage their students to take part in football, though the authorities know that knees, ankles, shoulders and back are likely to be so injured as to handicap the man throughout life. This is no merely academic proposition, as is evident from the list of injuries reported officially in two institutions at the close of the 1905 season.

The recent discussions awakened by the increasing brutality of football tend to divert attention from other and far more important matters. Immense sums of money have been given for educational purposes, many times by men unfamiliar with college conditions but anxious to advance the good of their fellows in the most effective way. One can hardly imagine that they expected their money to be employed in the encouragement of semi-professional organizations and in developing the shirking propensities of young men. One may well ask if colleges are acting in good faith toward their benefactors, toward parents as well as toward the students themselves.

The college course covers four years and much is said about the necessity for shortening it; the technical courses cover four years and much is said about the necessity of lengthening them. The writer believes that the college course should cover four years and that four

years is a barely sufficient period for a proper technical course. But what are the conditions? As has been said, the active members of organizations are required to maintain respectable standing as students; during football season, a member of the team can do very little studying, as he has no time; even if he should have time he could have no disposition. His attention is distracted too often by the necessity of nursing bruises, of repairing other damages or of seeking rest for a time in the hospital. Other organizations do not require similar physical racking but equal waste in energy and loss in time causing similar unfitness for study. In large institutions comparatively few individuals suffer in this way, as there is no duplication on teams, but in a small college the same men are on several lists, so that the football hero of November may be a brilliant star in the glee club during winter and a mainstay of baseball in spring. Yet with few exceptions these men make good all their losses and gain their degrees in technical schools quite as well as in colleges. Far be it from the writer to say that the course has been adjusted deliberately to meet the necessities of these champions; but the fact remains that these men to whom study, in the true sense of the word, is practically out of the question during a considerable part of the college year, do succeed in completing the course. It is certain that neither the college course nor that of the technical school requires four years of study for its completion—though it ought to. And it may be remarked parenthetically that this is equally true of the constantly lengthening period demanded by secondary schools for preparation, since in those schools also the advertising value of interscholastic contest is appreciated to its full extent. The requirements for entrance to college courses have been increased so little during the last forty years that a city lad of ordinary ability ought to be ready to enter college by the time he is sixteen years old.

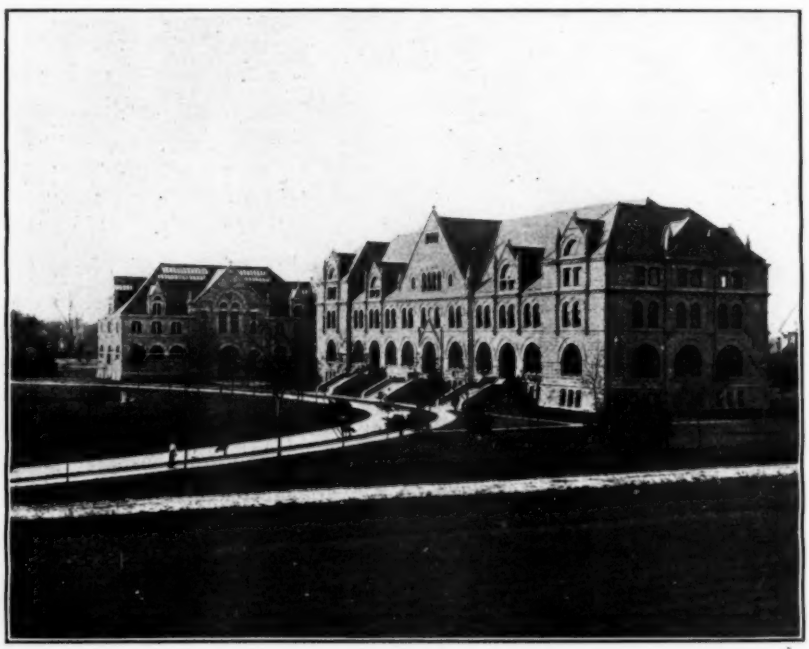
If intercollegiate contests are to be continued as a part of college operations, simple honesty requires that a change be made in the arrangement of studies. Men who wish merely to learn, who have no ambition to shine in athletics, glee clubs or other organizations, should not be compelled to hang around college or technical school for four years. They should have the opportunity to finish their work in proper season and to avoid the loss of a year or of a year and a half at the critical period of life. The college circulars should be very clear in explaining the conditions, so that parents might be able at the outset to decide in which division to place their sons. Those who are willing to have their sons 'get through' as well as those who desire to have their sons receive a generous intellectual training would make their arrangements intelligently and there would be no longer room for complaint.

THE PROGRESS OF SCIENCE.

THE CONVOCIATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science meets at New Orleans from December 29 to January 4. The place of meeting is somewhat remote from the main centers of scientific activity, and the attendance will scarcely be as large as when the association meets in one of the sea-board cities. But those who are able to attend will find the meeting of more than usual interest. A particularly good and unexpectedly large meeting of the American Economic and Historical Associations was recently held at New Orleans, and one of the pleasantest meetings of the American Association was held several years since at Denver. When the surroundings are new to many of the members—and New Orleans has many of the attractions of a foreign city—the meeting is likely to assume a more individual character and to profit both from the unusual conditions and from the greater intimacy into which the members are brought with one another.

There is of course no danger from yellow fever at New Orleans; indeed the complete suppression of the recent epidemic by scientific means will add to the interest of the meeting. This has been made the occasion for a special discussion on yellow fever and other insect-borne diseases, which will be taken part in by a number of those who have contributed in important measure to our knowledge of the causes and remedies of these diseases. The southeastern and central passenger associations have offered a rate of one fare and twenty-five cents to New Orleans, which is more favorable than



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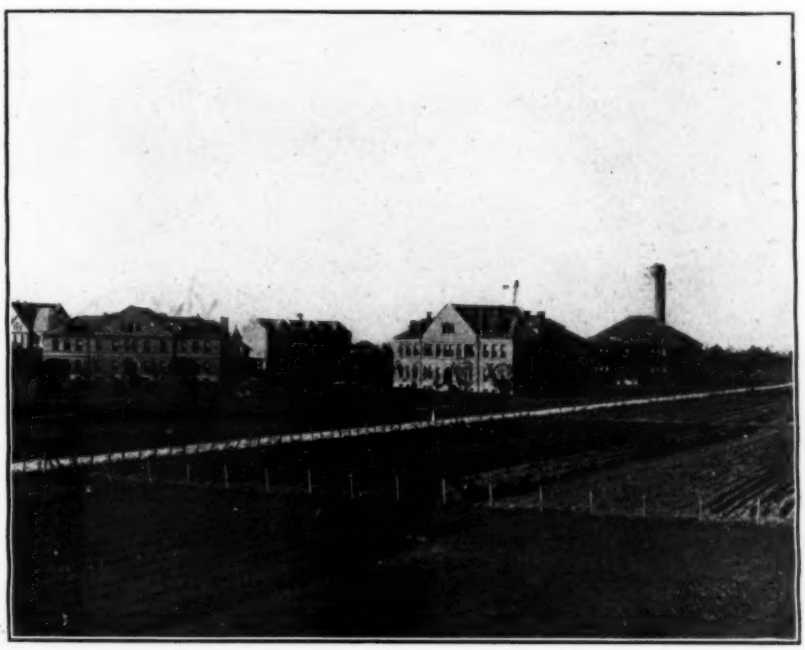
the association has hitherto been able to obtain and should lead many members to take advantage of it. New Orleans can be reached from New York City by a journey of two nights and one day.

The first general session of the association convenes on the morning of Friday, December 29, when the members will be welcomed by the governor of the state, the mayor of the city and the president of Tulane University, to whom the president-elect, Professor C. M. Woodward, of Washington University, will reply. The retiring president, Professor G. W. Farlow, of Harvard University, will give an address in the evening on 'The popular conception of the scientific man at the present day.' Each of the ten sections of the association will offer an attractive scientific program, and arrangements have been made for numerous excursions, receptions and the like. Most of the meetings will be held at the Tulane University, an institution which in recent years has made great progress, which on the material side is shown by the illustrations here given.

The American Chemical Society, the Botanical Society of America and several other scientific societies meet in affiliation with the association, but there is this year a wide scattering of the societies which last year met together in Philadelphia in convocation week. The American Society of Naturalists, with the special societies devoted to zoology, botany, physiology, bacteriology and anatomy, meet together at the University of Michigan; the societies devoted to mathematics, astronomy, physics and paleontology meet in New York City; the students of philosophy and psychology go to Harvard University, where a new building to be devoted to these subjects is to be formally opened; the anthropologists meet in Ithaca, and the geologists at Ottawa.

There are certain attractions in a meeting of scientific men having common interests at a small university town that a large assemblage in a city



TULANE UNIVERSITY.

MEDICAL DEPARTMENT OF THE TULANE UNIVERSITY.

does not possess. There are, however, also certain disadvantages. For example, many scientific men this year are in doubt as to which of the meetings they should attend, and there is no opportunity for the assembling of a general council of scientific men and for the numerous committee meetings

THE H. SOPHIE NEWCOMB COLLEGE FOR WOMEN OF THE TULANE UNIVERSITY.

which can to advantage take place during convocation week. Neither can the societies singly exert the influence on the public and on public affairs which they can hope to gain by united effort. The best solution of the problem would probably be for the American Association and all our scientific societies to meet together in one of our larger cities in the winter and to arrange for a smaller and less technical meeting at one of the university towns in the summer; and, so far as possible, for the societies that wish to hold separate meetings to call them at times that will not interfere with the great convocation week meetings.

AWARD OF THE NOBEL PRIZES

On December 10, the anniversary of the death of Alfred Nobel, the great prizes established by his will were awarded for the fifth time. The award for the promotion of peace to the Austrian Baroness von Suttner for her novel, entitled 'Die Waffen nieder,' and that to the great Polish novelist, Henryk Sienckiewicz, for literary work in an idealistic direction, do not fall within the immediate scope of this journal. The prize in physiology and medicine goes to Professor Robert Koch, that in physics to Professor Philipp Lenard, and that in chemistry to Professor Adolf von Baeyer.

Each of the recipients has a world-wide reputation for scientific research and discovery. Dr. Koch has the great distinction of having discovered the bacilli of tuberculosis and of cholera. His tuberculin has failed as a remedy, but has proved of great value in diagnosis. His researches on malaria, rinderpest and various tropical diseases have been contributions of vast importance for the study and cure of disease. Dr. Koch does not hold a university position, and like Dr. Behring, to whom a Nobel prize was awarded in 1901, he earns money by his discoveries. They have been criticized for this, but it may be that the greatest advances in science will come when investigators are paid directly for their work instead of indirectly as at present. Dr. Koch was born in Clausthal in 1843; he studied at Göttingen and carried on his researches for some years as a practising physician in small towns. In 1880 he became an officer of the Imperial Bureau of Health at Berlin, and in 1885 was appointed director of the Berlin Laboratory of Hygiene and professor in the university. He has, however, been chiefly engaged in expeditions to tropical countries under the auspices of the German and other governments, and is just now returning to Berlin from South Africa.

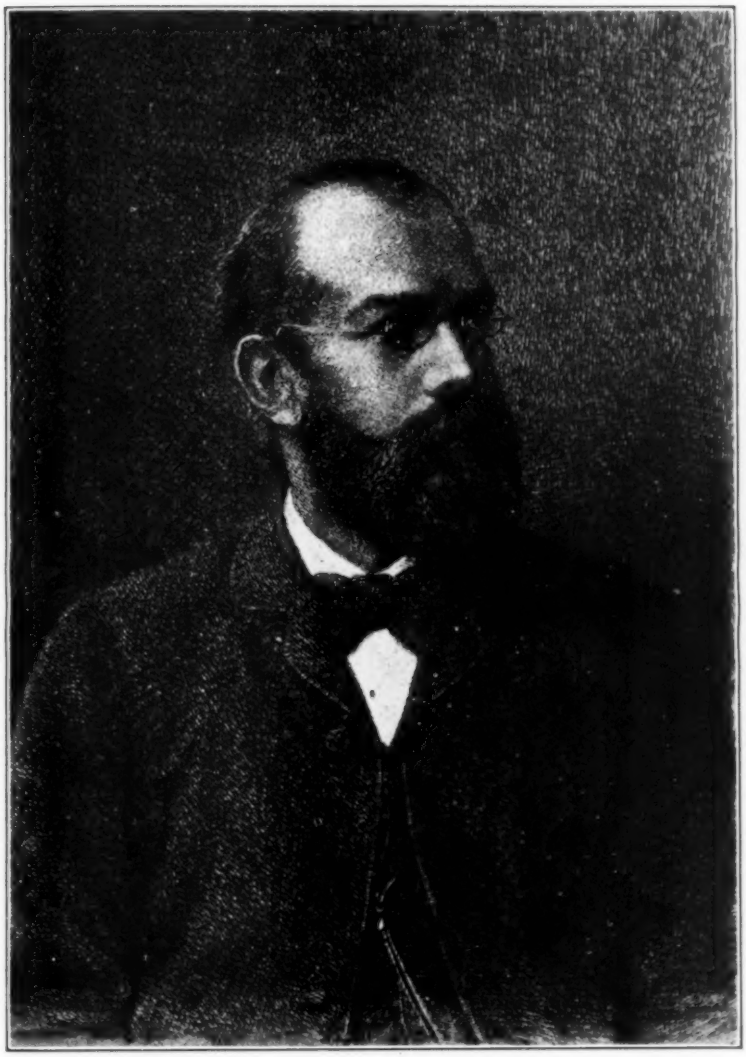
Professor Lenard, of Kiel, is distinguished for the discovery of the rays that bear his name, which was an important step forward in the direction of research which has become dominant in recent physics, the phenomena of radiation and the theories of the constitution of matter, with which the names of Röntgen, Becquerel and the Curies, who have already received Nobel prizes, are associated, and to which Thomson, Rutherford and Crookes have contributed in equal measure. Lenard was born 1862, studied at Heidelberg and at Berlin, and has filled teaching positions in Bonn, Breslau Heidelberg and Kiel. He has accomplished much valuable work in addition to his release of the cathode rays from the Crookes tubes, but he is scarcely the peer of Lord Kelvin or Professor J. J. Thomson, neither of whom has received a Nobel prize.

Baron von Baeyer, of Munich, has made contributions of great importance to organic and industrial chemistry. His work on the carbon compounds is of much theoretical interest, but he is most widely celebrated for the discovery of aniline dyes and the artificial production of indigo. Professor von Baeyer celebrated his seventieth birthday on October 31. Born in Berlin, he studied there, and at Heidelberg and Geneva. He qualified as *Dozent* at Berlin in 1860 and became full professor of chemistry at the newly-organized University of Strasburg in 1872, succeeding Liebig at Munich in 1875.

ALFRED NOBEL.

He was made a noble with hereditary transmission of the title in 1885. His great work in synthetic chemistry entitles him to belong to the group of those who have already received Nobel prizes in chemistry—van't Hoff, Fischer, Arrhenius and Ramsay.

These Nobel prizes, each of the value of about $40,000, were established by the will of Alfred Nobel, who died in 1896. Nobel was born in Stockholm; he studied in St. Petersberg, and began to assist in his father's engineering works, but soon took up the study of high explosives. In 1864 he took out a patent for dynamite, obtained by incorporating nitro-glycerine with some porous substance. Later he invented ballistite, a nitroglycerine smokeless powder, but his claim that the patent covered cordite was disallowed by the courts after a lawsuit against the British government. From the manufacture of dynamite and other explosives at his works in Ayrshire and from developing the Baku oil-fields, he



R. Koch

amassed the great fortune with which he founded the prizes that bear his name.

THE DETERMINATION OF SEX

At the New Haven meeting of the National Academy of Sciences, held in November, Professor Edmund B. Wilson presented the results of observations that constitute an important step towards the solution of the long standing problem of the determination of sex. These observations demonstrate that in several genera of insects, belonging to the Hemiptera, sex is predetermined at least as early as the fertilized egg, and

may be traced to antecedent conditions that preexist in the germ-cells before their union. In most of the species the spermatozoa are predetermined as male-producing and female-producing forms, equal in number, that differ visibly in the constitution of the nuclei. The differences between the two classes do not appear in the mature spermatozoa but are plainly apparent in the process of their formation. In some cases the female-producing spermatozoa contain one more chromosome than the male-producing ones, in others both classes have the same number of chromosomes but one of them is much smaller in the male-producing class. These initial differences in the spermatozoa lead to corresponding differences in the nuclei of the two sexes, the cells of females either containing one more chromosome than those of males or showing a greater quantity of chromatin in the greater size of one of the chromosomes. The sex of the individual may, therefore, be recognized in these cases by simple inspection of the dividing cells.

Although these visible differences are of wide occurrence in these insects they are not always present, for in one of the genera male-producing and female-producing spermatozoa can not be distinguished by the eye and the nuclei of the two sexes have the same appearance. This case is, however, connected by almost insensible gradations with those in which the differences are plainly apparent, and it is hardly possible to doubt that sex-production conforms to the same type throughout the series. It is, therefore, not improbable that two classes of spermatozoa, predetermined as male-producing and female-producing forms, may exist in animals generally, even though they are not, as a rule, visibly distinguishable.

It is not yet known whether this also applies to the eggs before fertilization. In these insects there is no visible indication of such a predetermination, but several cases are known in which the eggs are of two sizes before fertilization, the larger ones producing females and the smaller ones males. It is, therefore, possible that in animals generally, both eggs and spermatozoa may be predetermined as male-producing and female-producing before their union. In any case these observations bring a strong support to the view, which has rapidly gained ground in recent years, that sex is predetermined at least as early as the fertilized egg, though they do not exclude the possibility that in some cases sex may be affected by conditions acting upon the embryo subsequent to fertilization. It does not yet clearly appear how these new results can be applied to an explanation of sex-production in parthenogenesis, in hermaphrodites and in such cases as that of the bee where all the fertilized eggs are of the same sex. A new basis has, however, been gained for the investigation of these questions, and also for an interpretation of sex-production in accordance with the Mendelian principles of heredity, the probability of which has been urged by Castle, Bateson and other writers.

TWO GERMAN DIRECTORIES

THERE appeared in November the fifteenth annual edition of 'Minerva' and a little earlier a German 'Wer Ist's.' The former of these works is well known to scholars throughout the world. It is an invaluable address book containing the names and chairs of the professors in the universities and other institutions of higher education of all countries, the officers of libraries, museums, academies, etc., and much information in regard to the organization of these institutions. The editing is a model of careful exactness; it requires some search to find a misspelled name among the 40,000 in the book. The work is brought out with unusual promptness. It appeared early in November and contains changes up to October. Each year a portrait of an eminent scholar is given as a frontispiece. This year Dr. Sophus Müller, director of the National Mu-

seum at Copenhagen was selected, and the portrait is here reproduced.

There is of course room for criticism even of this excellent book. If an editor could be found in each country who would revise the data with a view to uniformity, some substantial gain would result. The data obtained from the separate institutions are not always comparable. Thus for some American

DR. SOPHUS MÜLLER.

institutions both professors and instructors are included, for others the professors only. In the German universities the names are arranged under faculties by seniority, but it is impossible to discover what plan has been followed in some American institutions. Professor Wolcott Gibbs, the dean of Harvard professors and of American men of science, and Professor Charles Eliot Norton are omitted from the Harvard list, though emeritus professors are included in other institutions. Sometimes the names are given in full and sometimes they are abbreviated without any apparent system, the names not being printed as they should be written—Th. may be used for T, Will. for William or W, etc. The inclusion of institutions is not consistent. Thus the Philadelphia High School is admitted, but not the College of the City of New York. The Armour and Rensselaer Technological Institutes are admitted, but not the Stevens and Worcester Institutes. The Philadelphia Zoological Garden and the St. Louis Botanical Garden are admitted, but not the similar institutions of New York, etc. The statistics are not uniform. Thus Columbia is given as the largest American university, followed by Chicago and California. Cairo, Budapest, Moscow, Madrid and Naples are in the list of the nine largest universities of the world.

A German 'Who's Who' will be of much service both there and here. A French 'Dictionnaire des Contemporains,' which is unfortunately now twelve years out of date has been issued, but no similar book had been compiled for Germany. We regret, however, to say that 'Wer Ist's' (H. A. L. Degener, Leipzig), is an example of bad editing. The introduction is amusingly pretentious. We are told that the work will contribute to 'einer grossen deutschen Friedensweltmacht' and much more to the same effect. Such a book should not attempt to be international in character. It is impossible to guess how the American names were selected. 'Rooseveld' indeed will be found, who organized 'Rauhen Reiter' and wrote about 'das rastlose Leben,' but not Mr. Cleveland. 'Murray N. Butler, L.L.D.,' of Columbia University, is there, but not President Eliot, of Harvard University. Numerous Americans are included for no evident reason, but not men such as Mr. Carl Schurz, Mr. Andrew D. White or Mr. Charlemagne Tower, whose relations with Germany are intimate. In one short sketch there are fourteen typographical errors. When the editor says that the subjects of the foreign sketches are contemporaries 'über die wir so gut wie Nichts wissen,' it may be assumed that the editorial 'we' was not intended, but it would have a cer-

tain appropriateness. The German biographies are of course much better, though by no means free from errors, and there are many omissions. Thus Professor Lenard who has just now received a Nobel prize is not included. The book will doubtless be improved in subsequent editions; but even now it is decidedly useful to those who have relations with the public men and scholars of Germany.

SCIENTIFIC ITEMS.

WE regret to record the deaths of Professor Albert von Köllicker, the eminent anatomist and zoologist; of Sir John Scott Burdon-Sanderson, formerly Wayneflete professor of physiology and regius professor of medicine at Oxford; of Dr. Gustave Dewalque, formerly professor of geology at Liège, and of Dr. E. Oustalet, professor of zoology in the Natural History Museum of Paris.

DR. HENRY S. PRITCHETT has resigned the presidency of the Massachusetts Institute of Technology to become president of the Carnegie Foundation for pensioning college professors. —Dr. Friedjof Nansen will shortly go to London as minister from Norway.— Dr. George H. Darwin, F.R.S., Plumian professor of astronomy and experimental philosophy at Cambridge, has been knighted by King Edward.—Lord Rayleigh has been elected president of the Royal Society in succession to Sir William Huggins.

THE statue of Benjamin Silliman has been removed from its site on the old campus of Yale University, near the library, to a place between the Sloan and Kent laboratories.—A bust of the late Professor M. Nencki has been unveiled in the chemical department of the Institute of Experimental Medicine, St. Petersburg.—A memorial to Theodore Schwamm, regarded as the originator of the cell theory, is to be erected in his native birthplace, Reuss.

THE Hayden memorial gold medal of the Academy of Natural Sciences of Philadelphia, has been voted to Dr. Charles D. Walcott, director of the United States Geological Survey.— Medals were awarded by the recent Congress of Tuberculosis to Drs. Koch, of Berlin; Brouardel, of Paris; Bang, of Copenhagen; Biggs, of New York; Broadbent, of London; and von Schroetter, of Vienna.—The French Academy of Moral and Political Sciences has decided to award the François-Joseph Audiffred prize, of the value of $3,000, which is given in recompense of the most beautiful and greatest acts of self-devotion of whatever kind they may be, to Professor Calmette, director of the Pasteur Institute at Lille.

THE following is a list of those to whom the Royal Society has this year awarded medals: The Copley medal to Professor Dmitri Ivanovitch Mendeléef, of St. Petersburg, for his contributions to chemical and physical science; A Royal medal to Professor John Henry Poynting, F.R.S., for his researches in physical science, especially in connection with the constant of gravitation and the theories of electrodynamics and radiation; A Royal medal to Professor Charles Scott Sherrington, F.R.S., for his researches on the central nervous system, especially in relation to reflex action; the Davy medal to Professor Albert Ladenburg, of Breslau, for his researches in organic chemistry, especially in connection with the synthesis of natural alkaloids; the Hughes medal to Professor Augusto Righi, of Bologna, on the ground of his experimental researches in electrical science.